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NON-PRESSURE TREATMENTS OF ROUND NORTHERN WHITE CEDAR TIMBERS WITH CREOSOTE

A REPORT OF AN INVESTIGATION

CONDUCTED BY

THE ENGINEERING EXPERIMENT STATION
UNIVERSITY OF ILLINOIS

BY

EVERETT EDGAR KING

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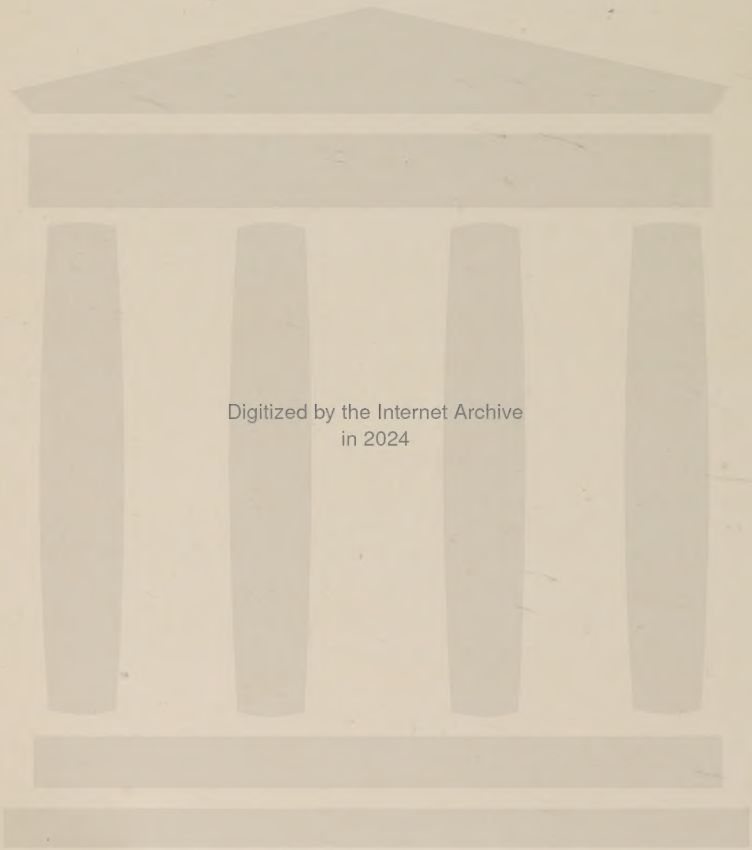
ABSTRACT

This publication outlines in some measure the work involved in a series of tests made to study the effect of a number of non-pressure processes commonly used in the treatment of wood with creosote in extending the life of northern white cedar posts and poles exposed to the agencies of decay, and sets forth the records and findings in such a form as to represent a summary of the results.

The methods of treatment include brushing, dipping, steeping, and double-tank processes. Some of the timbers were incised before treatment; others were left plain. Still others were left untreated, to serve as a check on the effectiveness of these several preservative processes.

The specimens, approximately 42 inches in length, provided from 180 seven-foot and 186 ten-foot posts, were treated in the summers of 1922 and 1923 and were allowed to remain in an unprotected position in the soil for a period of twenty years. They were inspected at regular intervals in order to secure data for an accurate record of their behavior throughout the duration of the tests.

The findings of the observations and investigations are recorded in some detail in the several diagrams and tables throughout the text and in Appendix A, and the analyses of the preservative oil originally injected into the wood together with that remaining in the wood at the end of the twenty-year period are summarized for comparison.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NON-PRESSURE TREATMENTS OF ROUND NORTHERN WHITE CEDAR TIMBERS WITH CREOSOTE

I. Introduction

1. *Preliminary Statement: Decay and Preservation of Wood.*— Most timbers not destroyed by mechanical wear fail by decay. Hence its prevention is economically important to a variety of users, including railroads, power-development and communication companies, farmers, and others who employ wood in construction.

Decay is the result of fungus and bacterial growth in the fibers of wood. The fungus is a threadlike parasitic plant that feeds on the structural elements in the walls of the wood cells. As this plant grows from cell to cell it dissolves these elements, principally cellulose and lignin, for its own food supply and thus breaks down the structure of the wood, leaving a brownish incoherent residue called decay.

For successful propagation the fungus requires not only a food supply, but also air, some moisture, and a rather warm temperature.

On a commercial scale neither the air supply nor the temperature range of timbers continually in contact with the soil can be controlled. The moisture content, however, can be controlled to some extent, and a toxic element applied in order to poison the food supply. Since there are many limitations on controlling the moisture, the latter procedure is the more economical. Creosotes serve the purpose excellently. They are highly toxic to fungus growth, are not highly volatile, do not dissolve in water, and hence are not readily leached.

Pressure processes of applying the preservative are the most economical for a large percentage of structural timbers, especially the larger sizes of the harder and denser varieties. However, non-pressure processes have value also. They are simple. They require little expenditure for labor and equipment. Moreover, they are particularly effective in treating well-seasoned wood that has a porous shell; the preservative can readily penetrate the outer fibers and form a seal against external agencies of decay. The stronger the seal and the longer it remains unbroken, the more effective the treatment.

Non-pressure processes have an additional advantage. Under most circumstances the upper portion of posts and poles whose butts are set in ground that is rather moist throughout the year will have a comparatively long life, but the sapwood of the butt will decay in a relatively short time unless protected. No means have been devised for treating a portion of a timber successfully by pressure processes,

whereas there are several methods of doing so by non-pressure processes.

2. *Nature and Purpose of Tests.* — It was therefore the purpose of the tests herein reported to determine in a measure the relative effectiveness of various non-pressure methods of treating with creosote a wood whose structure permits it to be successfully treated in this manner. The wood chosen was round northern white cedar (Thuja Occidentalis), commonly used for posts and poles. This wood is well adapted to non-pressure treatment because its heartwood naturally resists decay and its sapwood is porous. When, therefore, this sapwood shell is treated, the life of the structure is materially prolonged without the expense of treating the "core," or innermost part of the timber.

3. *Acknowledgments.* — The work was carried on as a part of the program of the Engineering Experiment Station of the University of Illinois. It was done under the general administrative direction of Deans C. R. Richards, M. S. Ketchum, A. C. Willard, and M. L. Enger, successively directors of the Station from 1922 to date, and under the immediate supervision of Professors J. M. Snodgrass and E. C. Schmidt, successively heads of the Department of Railway Engineering, and Professor W. C. Huntington, head of the Department of Civil Engineering.

II. Description of Tests

4. *Specimens and Basic Procedures.* — To facilitate the treating processes and conserve material, the specimens to which preservatives were applied averaged about 42 in. in length; all surfaces, including both ends, were treated. Because neither end was sealed, it would be incorrect to assume that the data obtained from such 42-in. pieces would correspond exactly to the figures that would be obtained from treating this length of the butts of posts or poles. In treating the butt, however, some of the preservative would penetrate along the sapwood beyond the 42-in. point, thus offsetting to some extent any errors resulting from such an assumption. At all events, the data obtained from the processes presented in this publication are comparable.*

The timbers used had been cut in the northern Wisconsin woods — 180 into 7-ft. length, and 186 into approximately 10-ft. lengths, for posts. After all timbers had been cut and dried, and one set of them incised, creosote was applied in both hot and cold conditions, a total of four methods of application being used. The timbers were then set in the ground in an unsheltered location where they would be exposed to the agencies of decay. The soil was a well-drained black clay loam containing a small percentage of disintegrated cinders. Till 1943, when it became necessary to remove the specimens, the timbers were inspected annually.

5. *Non-incised Posts.* — Tests of non-incised posts began in May, 1922. One hundred eighty well-seasoned 7-ft. specimens ranging from 3.5 in. to 7 in. in diameter were cut in two. One-half of each 7-ft. post was treated; the other half was left plain. Both halves of each post were numbered. The bark of posts that had been cut during the summer months had already been cleanly peeled off. The inner bark of those cut during the winter months was either peeled off, or shaved off with a drawknife. The whole surface of each post was exposed to creosote, the tops of some specimens being cut at various angles — 90 deg., 67.5 deg., and 45 deg. — to permit study of the effects of slope across the top.

Moisture Content

Upon delivery, the posts were stored in relatively dry air for a month's seasoning. After each post had been cut in two, a moisture

* It was intended at the beginning of the investigation to study this phase of wood preservation rather intensively and to test round northern white cedar under various conditions of soil, drainage, and ground-cover growth. The experiments herein reported were to be preliminary, yielding observations that would aid in scheduling a course of procedure. Limitation of funds, however, made it necessary to use as the basis for this bulletin data that were intended to serve as a guide toward a more extensive research.

sample about ¾ in. thick was taken at the freshly cut point. The samples were at once weighed on scales reading to tenths of a gram and were then heated for 24 hr. in an electric oven at a temperature slightly above 212 deg. F. Re-weighing was followed by further heating in the oven during 24-hr. periods until the weight of each sample became constant.

Tables 1A, 2A, 3, and 6 show the average moisture content for each series of tests. It averaged a little below 10 per cent of the oven-dry weight of the wood. This is substantially lower than the ratio generally found in outdoor timbers.

6. *Incised Posts.* — In 1923, the range of tests was extended to include a study of the value of incising timbers for the purpose of allowing the preservative oils to penetrate more deeply without appreciable impairment of the structure of the wood.

Like the posts used in the first set of tests, these ranged from 3.5 to 7 in. in diameter. Their original length, however, was somewhat over 10 ft. Each was cut into three pieces of equal length, 42 in. The two pieces of each post that were to be treated were cleaned of bark, and one of them was then incised over nearly its whole area. The specimens were then treated with creosote under virtually the same conditions and over virtually the same ranges of time and temperature previously described. The third piece of each post was left untreated.

The tops of all specimens were cut off — one-third at an angle of 90 deg., one-third at 67.5 deg., one-third at 45 deg.

The Incisions

The purpose of the incisions was to open the sapwood in order to permit a deeper penetration of the preservative oil without appreciably weakening the structural value of the wood.

The incisions, parallel to the grain and ½ in. deep (slightly more than the thickness of the sapwood in the average post), were cut over the circumferential surface of the timber to within 3 in. of each end. Two spacings of incisions were used, to determine their effects on oil penetration. On 160 specimens the incisions were 1½ in. longitudinally. On 26 specimens (listed at the end of Table 6 and the end of Table 9D) they were 2 in. longitudinally. The other dimensions were identical on all 186 posts — ⅛ in. stagger and ½ in. circumferential.

Several pole-treating plants use power-driven incising machines to puncture the sapwood surface of pole butts in order to increase the absorption of the preservative. Such machines have to be specially

made, to handle knotty and irregularly shaped timbers as well as curved and tapered surfaces. Equipment suitable for incising flat pieces such as boards and railroad ties is not sufficiently flexible. In the tests herein reported, the work was done by hand because of difficulties involving time, expense, and operating conditions. Though tedious, hand-incising insured a uniform depth of cut regardless of knots and irregularities in the timber surfaces. The incision pattern was accurately laid out on each specimen, and the incisions were cut true to measurement and specified depth. The pattern is shown in Fig. 1; the dimensions of the incising tool, in Fig. 2.

Moisture Content

Like the posts in the previous lot, the incised posts were well seasoned when bought. Their further treatment was identical with that already described. For the 186 specimens the moisture content averaged about 8.8 per cent of the oven-dry weight of the wood, as shown in Tables 1A, 2A, 3, and 6.

7. *The Preservative.* — Most creosotes used in wood preservation are by-products of the distillation of bituminous coal in the process of making gas, tar, or coke. The grade of creosote used in the tests

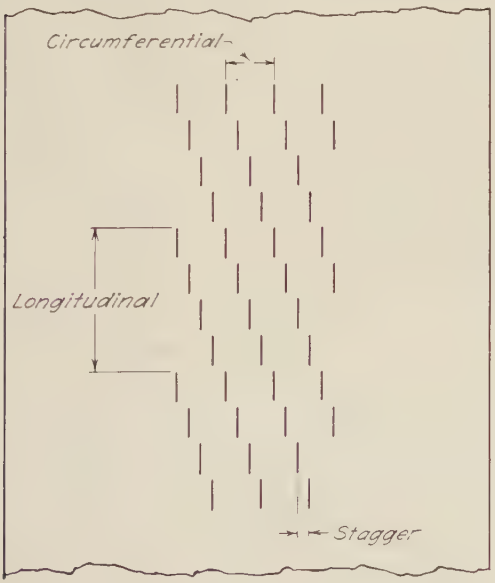

Fig. 1 (at Left). Spacing of Incisions

Fig. 2. Incising Tool

was that prepared especially for the surface treatment of wood — a grade of carbolineum or anthracene oil made with a higher boiling point than that of ordinary creosotes used in pressure processes — because it was believed such an oil would remain in the wood for a longer time than creosotes used in pressure processes, and thus would to some extent offset the disadvantage of rather shallow penetration.

8. *Characteristics of the Preservative Oil.* — The preservative oil used in all tests made during the summer of 1922 showed the following characteristics, as determined by the Applied Chemistry Laboratory of the University of Illinois under the direction of Dr. J. M. Lindgren:

Specific gravity at 15.5 deg. C	1.199
Free carbon, insoluble residue	0.237%
Tar acids	2.20 %
Sulfonation	0.30 %
Distillation	
Per cent distilled up to 235 deg. C	8.6
Per cent distilled up to 300 deg. C	35.2

The preservative oil used in the tests made during the summer of 1923 showed the following characteristics, as determined by the same laboratory:

Matter insoluble in benzol	0.23 %
Distillation	
Up to 210 deg. C	2.06 %
210–235	7.78 %
235–315	41.27 %
315–355	22.74 %
Residue	26.00 %
Specific gravity at 38/15.5 deg. C	1.087
Specific gravity of fraction between 235 and 315 deg. at 38/15.5 deg. C	1.048
Specific gravity of fraction between 315 and 355 deg. at 38/15.5 deg. C	1.120
Float test at 70 deg. C	22 sec.

9. *Preservative Processes.* — Comparisons of the amounts of creosote absorbed per unit volume by the timbers treated by the different processes, or even between those treated by the same process, are useful in only a general way. Individual specimens and even whole groups may vary widely from the averages because of differences in the structural characteristics of the same woods. The rate of growth of two adjacent trees of the same variety may differ considerably.

Again, the upper part of a tree may differ somewhat from the lower part; and ability to withstand decay with or without treatment is influenced to some extent by these characteristics of individual timbers.*

The processes of applying the preservative in these tests included brushing, dipping, steeping, and hot-and-cold bath, generally known as double-tank or open-tank.

10. *Brushing Treatments.* — The brushing treatments were applied to 96 posts, 72 non-incised and 24 incised. Forty-eight timbers were treated with the preservative "cold" (70–90 deg. F.) and the same number with it "hot" (180–220 deg. F.; in a few cases slightly higher).

Four lots of 24 posts each received one, two, three, and four applications, respectively. The 72 specimens that received more than one coat were allowed to dry after each application. To determine the amount of preservative oil absorbed, they were weighed before treatments were begun and after each application. The moisture content shown in Table 1A was that of the wood at the beginning of the first application. Thereafter the posts were kept outdoors — a procedure that might have increased the moisture content somewhat, though the air was fairly dry. This increase might, in turn, have caused slight error in determining the weight of the creosote absorbed and in decreasing the amount of absorption in subsequent applications.

Table 1A gives the results of these tests.

Absorption per cubic foot of post was as follows:

	Cold oil	*Hot oil*
Non-incised wood		
1 application	1.07 lb.	1.15 lb.
2 applications	1.53 lb.	1.98 lb.
3 applications	2.01 lb.	3.16 lb.
4 applications	2.73 lb.	2.95 lb.
Incised wood		
1 application	0.46 lb.	2.43 lb.
2 applications	1.38 lb.	3.41 lb.
3 applications	5.17 lb.	7.45 lb.
4 applications	5.85 lb.	6.33 lb.

A summary of these values is given in Table 1B. The average absorption in pounds per cubic foot for the 72 non-incised specimens during one application was 1.07 for the 36 treated in cold preservative and 1.15 for the other 36, treated in hot oil. For 54 posts of this lot which received two applications, the average was 1.74 for the 27 posts

* While, as a matter of convenience, the tests were applied to posts, the processes are, in general, applicable to poles of the same variety of wood. It must be understood, of course, that the results of these tests do not apply to all woods in general, but to this particular variety, only, or at most to one or two others that are very similar in character.

treated "cold" and 2.26 for the 27 treated "hot." For 36 that received three applications the figures are 2.18 for the 18 treated "cold" and 2.73 for the 18 treated "hot." For 18 of the set that received four applications the figures are 2.73 and 2.95.

All 24 incised specimens received at least one application, 12 specimens "cold" and 12 "hot"; eighteen received two applications, 9 "cold" and 9 "hot"; and so on. The figures for those treated "cold" are 1.65, 3.23, 5.10, and 5.85; for those treated "hot" they are 3.05, 4.53, 6.32, and 6.33.

The increased absorption due to incisions may be of academic interest only, since steeping and double-tank processes without incisions give deeper penetration and since the expense of incising justifies a more effective method. Nevertheless it is worth noting that absorption reached as much as 6 lb. per cu. ft.

In comparing tests on the basis used above — absorption in pounds per cubic foot of wood — the diameter of the posts must always be considered. As will be seen later (pages 29 and 31), the protection offered to a 6-in. post by an absorption of 2.50 lb. per cu. ft. is about 50 per cent more than that offered to a 4-in. post by the same amount of preservative.

11. *Dipping Treatments.* — Of 78 specimens dipped, 54 were non-incised and 24 incised. Thirty-nine specimens were submerged in preservative ranging in temperature from 70 deg. to 90 deg. F., the other 39 in preservative ranging from 180 deg. to slightly higher than 220 deg. F. The 78 were divided into three groups of 18 each and one of 24. This largest group received one 15-min. immersion. Of the groups of 18, one received a 5-min. immersion; one received two 15-min. immersions; the other received three 15-min. immersions. The specimens were weighed and dried as in the previous tests.

The results of these tests are shown in Table 2A.

Absorption per cubic foot was as follows:

	Cold oil	*Hot oil*
Non-incised wood		
1 immersion (5 min.)	2.60 lb.	1.90 lb.
1 immersion (15 min.)	3.03 lb.	2.21 lb.
2 immersions	4.26 lb.	3.52 lb.
3 immersions	4.96 lb.	4.90 lb.
Incised wood		
1 immersion (5 min.)	5.20 lb.	6.75 lb.
1 immersion (15 min.)	7.08 lb.	7.52 lb.
2 immersions	9.32 lb.	9.21 lb.
3 immersions	10.28 lb.	12.28 lb.

A summary of part of the data of Table 2A is given in Table 2B. For 42 non-incised specimens given one 15-min. immersion, the absorption in pounds per cubic foot was 3.00 for the half treated in cold oil and 3.15 for the half treated in hot oil; for 24 of the same lot given two 15-min. immersions, the absorption was 4.00 for the half treated in cold oil and 3.95 for the half in hot; for 12 specimens of the same group given three 15-min. immersions, the absorption was 4.96 for the half treated in the cold bath and 4.90 for the half in hot.

Similarly, for 18 incised specimens treated for one 15-min. period, the absorption in pounds a cubic foot was 7.21 for the half submerged in cold oil and 9.16 for the half submerged in hot; for 12 of the same lot given two 15-min. immersions, the absorption was 8.91 for the half in the cold bath and 10.50 for the half in hot; for the 6 of the same group given three 15-min. immersions, the absorption was 10.28 for the half in the cold oil and 12.28 for the half in hot.

12. *Steeping Treatments.* — In the steeping test 194 specimens were used, 120 being non-incised and 74 incised. Groups and periods of immersion were as follows: 18 — ½ hr.; 18 — ¾ hr.; 24 — 1 hr.; 21 — 2 hr.; 24 — 3 hr.; 26 — 4 hr.; 21 — 5 hr.; 24 — 6 hr.; 18 — 7 hr. One hundred four were treated with the bath at a temperature of from 70 to 90 deg. F., and the other 90 at a temperature of 200 deg. F. or slightly higher. The results of these tests are given in Table 3.

Absorption per cubic foot was as follows:

Non-incised wood

Immersion period	*Cold oil*	*Hot oil*
½ hour	3.15 lb.	3.93 lb.
¾ hour	3.78 lb.	4.00 lb.
1 hour	4.86 lb.	2.74 lb.
2 hours	5.10 lb.	4.27 lb.
3 hours	5.45 lb.	7.43 lb.
4 hours	5.48 lb.	4.78 lb.
5 hours	8.45 lb.	7.64 lb.
6 hours	8.13 lb.	9.86 lb.
7 hours	11.40 lb.	10.00 lb.

Incised wood

½ hour	8.48 lb.	8.76 lb.
¾ hour	6.94 lb.	7.80 lb.
1 hour	9.03 lb.	8.01 lb.
2 hours	10.60 lb.	7.98 lb.
3 hours	11.45 lb.	9.65 lb.
4 hours	7.77 lb.	10.25 lb.
5 hours	10.31 lb.	10.85 lb.
6 hours	11.50 lb.	13.22 lb.
7 hours	11.57 lb.	16.10 lb.

The high rate of absorption throughout this set of tests as well as in the preceding tests is no doubt due, in part at least, to the unusually low moisture content of the timbers and the high porosity of the wood. The amount of absorption was as high as the amount retained when the empty-cell pressure process is applied to railroad ties and other structural timbers.

13. *Rate of Absorption During Steeping-Test Periods.* — The relative rates of absorption during immersion periods varying from 5 min. to 7 hr. for both non-incised and incised wood as found in Tables 2A and 3 are shown in Table 4 and Fig. 3, the curves in Fig. 3 being drawn continuously to represent values approximately average. The effect of the incisions was of course to increase the amounts of absorption of the preservative. This absorption during the first 30 min. was relatively high for both types of posts — 3.0 lb. per cu. ft. for non-incised and 7.5 for incised. After that time the difference grew less as the time increased, the deeper penetration of the heartwood no doubt accounting for some of this difference. During the remaining 6½ hr. the non-incised took up 7.2 lb. per cu. ft. and the incised 5.3 lb. per cu. ft.

14. *Relative Absorption During Dipping and Steeping Treatments.* — The relative absorptions of non-incised and incised timbers during similar immersion periods of dipping and steeping processes are shown in Table 5. Some advantage is indicated in favor of the dipping method.

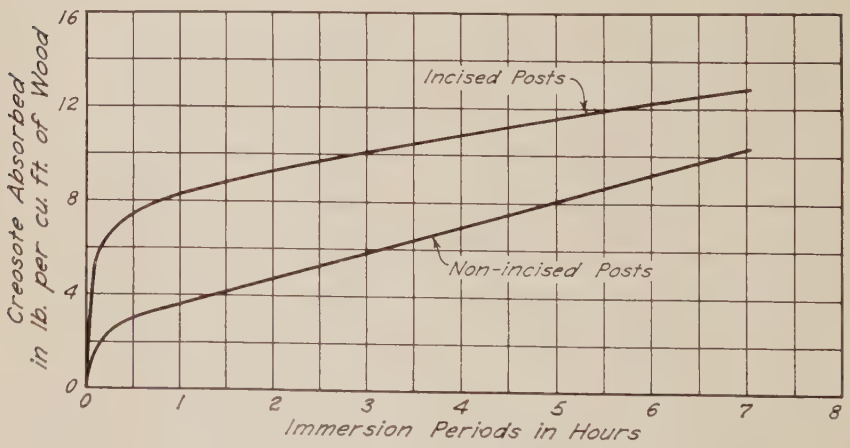

Fig. 3. Absorption per Cubic Foot of Wood During Periods of Immersion

15. *Double-Tank Treatment.* — The theory of the double-tank (open-tank, or hot-and-cold-bath) treatment is that after the wood has been immersed for some time in hot preservative it becomes heated and the air and moisture in the cavities of the cells are expanded. When the wood is removed from the hot oil and plunged immediately into cold oil, the air and moisture of the cells contract during the cooling process, thereby forming a partial vacuum. The external pressure of the air then drives the creosote a little deeper into the wood.

Of the 178 specimens treated by the double-tank method, 106 were non-incised, 45 were incised with incisions spaced 1½-in. longitudinal, ⅛-in. stagger, and ½-in. circumferential measurement, and 26 were incised with incisions spaced 2-in. longitudinal, ⅛-in. stagger, and ½-in. circumferential measurement. All incisions were ½-in. deep. The results of the tests are shown in Table 6.

Of the non-incised timbers, a group of 9 posts was submerged in the hot bath for a period of ¾ hr., after which it was removed, and placed immediately in the cold bath, and kept there for ½ hr. The amount of absorption was 7.08 lb. per cu. ft. of wood. A set of 21 submerged for 1 hr. in the hot bath and then for 1 hr. in the cold bath absorbed 10.07 lb. per cu. ft. A set of 14 pieces submerged in the hot bath for 2 hr. then in the cold bath for 1 hr. absorbed 11.13 lb. per cu. ft. A set of 11 given a 2-hr. hot bath and a 2-hr. cold bath absorbed 11.85 lb. per cu. ft. A group of 9 given a 3-hr. hot bath and a 1-hr. cold bath absorbed 11.81 lb., another lot of 9 immersed in hot oil for 3 hr. and in cold oil for 2 hr. absorbed 10.22 lb., and still a third lot of 9 immersed in hot oil for 4 hr. and in cold oil for 1 hr. absorbed 7.80 lb. per cu. ft.

For three groups of 6 each, results can be expressed thus:

No. of Specimens	Immersion Period (hot, then cold)	Absorption, lb. per cu. ft.
6	4 + 2	11.40
6	4 + 4	11.75
6	5 + 3	8.04

Finally, a lot of six immersed in hot oil for 4 hr. and then left in the bath while it cooled for 14 hr. absorbed 13.20 lb. per cu. ft.

Data concerning wood incised with 1½-in. longitudinal, ⅛-in. stag-

ger, and ½-in. circumferential measurement are as follows: One set of three pieces immersed in the hot oil for a period of ¾ hr. and then in the cold oil for a period of ½ hr., absorbed 10.60 lb. of the preservative. A lot of six submerged in the hot bath for 1 hr. and then in the cold bath for 1 hr. absorbed 12.98 lb. per cu. ft. Similarly, groups of three were submerged with the following results: 2 hr. in the hot bath and 1 hr. in the cold, absorbed 14.37 lb. per cu. ft.; 2 hr. in the hot bath and 2 hr. in the cold, 12.31 lb.; 3 hr. in hot oil and 1 hr. in cold, 20.60 lb. A lot of six immersed for 3 hr. in hot oil and 2 hr. in cold, absorbed 14.60 lb.; one of three for 3 hr. in hot oil and 3 hr. in cold, 15.03 lb.; one of three for 4 hr. in hot oil and 1 hr. in cold, 16.55 lb.; one of six for 4 hr. in hot oil and 2 hr. in cold, 14.60; one of three for 4 hr. in hot oil and 4 hr. in cold, 16.71 lb.; one of three for 5 hr. in hot oil and 3 hr. in cold, 11.35 lb.; and one of three for 4 hr. in hot oil followed by 14 hr. cooling, 18.79 lb. per cu. ft.

In the lot of twenty-six given incisions spaced 2-in. longitudinal, ⅛-in. stagger, and ½-in. circumferential measurement, one group of three immersed for ¾ hr. in hot preservative followed by ½ hr. in cold, absorbed 9.80 lb. per cu. ft. Another group of six immersed in hot oil for 1 hr. and then in cold for 1 hr., absorbed 11.12 lb., and a set of five immersed in hot oil for 2 hr. and then in cold for 1 hr. absorbed 12.15 lb. Four lots of three each immersed gave the following results: 2 hr. in hot oil and 2 hr. in cold, 15.92 lb.; 3 hr. in hot oil and 1 hr. in cold, 16.61; 3 hr. in hot oil and 2 hr. in cold, 14.65; and 4 hr. in hot oil and 1 hr. in cold, 7.36 lb. per cu. ft.

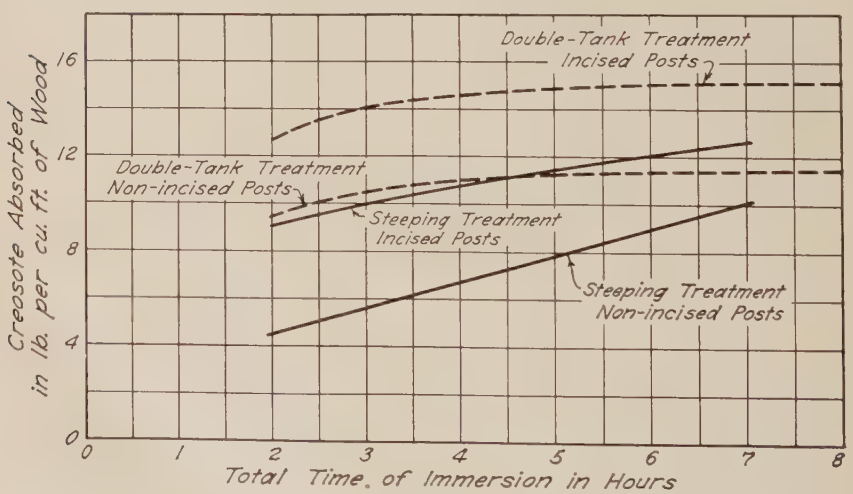

Fig. 4. Relative Absorption During Steeping and Double-Tank Treatments

16. *Relative Absorption During Steeping and Double-Tank Treatment.* — Table 7 shows (for both non-incised and incised wood) the relative absorption of the preservative during the steeping and double tank treatments for the same number of total hours covering the immersion period or periods, and indicates the apparent relative advantages of the double-tank process. The accompanying graph, Fig. 4, in which the curves are drawn continuously to represent approximately average values, shows that the non-incised timbers retained about as much preservative by the double-tank method as the incised timbers did by the steeping process; incising is of course much more expensive. This is not to say, however, that the non-incised specimens will last longer simply because they retained more of the preservative. The penetration is likely to be unevenly distributed around the circumference of the post — slight over one portion of the perimeter where the wood is more dense, and heavy over the rest of the section, as shown in Fig. 5. As the figure indicates, this uneven distribution may afford an opportunity for decay to begin where the penetration is light. Examinations made during these tests have shown that in practically all the unsound non-incised treated posts decay has operated in a sort of pocket on one side instead of around the perimeter, beginning where the penetration was light. In the incised timbers, the shell of penetration was practically uniform around the section, and thereby afforded better protection for the inner wood, as indicated in Fig. 6. The importance of this point must be strongly emphasized.

17. *Graphical Summary of Absorption in Pounds per Cubic Foot for the Various Processes.* — Figure 7 presents graphically, for both non-incised and incised posts, a summary of the absorption of the preservative in pounds per cubic foot of wood for the different treating processes. The figures for brushing, dipping, and steeping are averages between cold and hot treatments.

18. *Treating Tank.* — The dipping, soaking, and double-tank treatments were all made in a rectangular open-top steel tank provided with a suitable cover. Because creosote is so inflammable that fire should not come in contact with its container, the oil was heated by means of a steam pipe laid along the bottom of the tank. The entire half of each post treated was immersed in the preservative oil, and a weight placed on it to keep it submerged. The timbers were removed from the tank by means of steel tongs in order to protect the workmen's hands from the creosote, which has somewhat the same effect on the skin as carbolic acid.

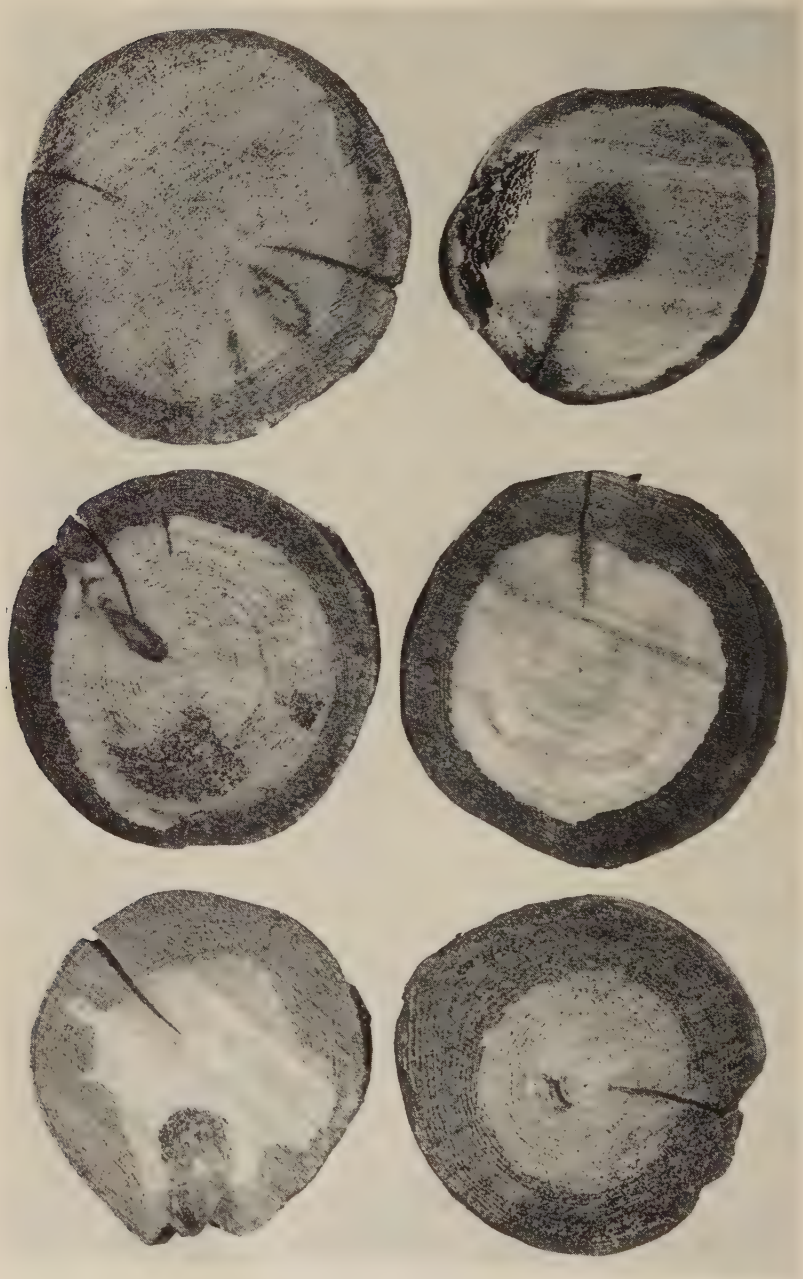

FIG. 5. IRREGULARITY OF PENETRATION OF THE PRESERVATIVE IN NON-INCISED WOOD

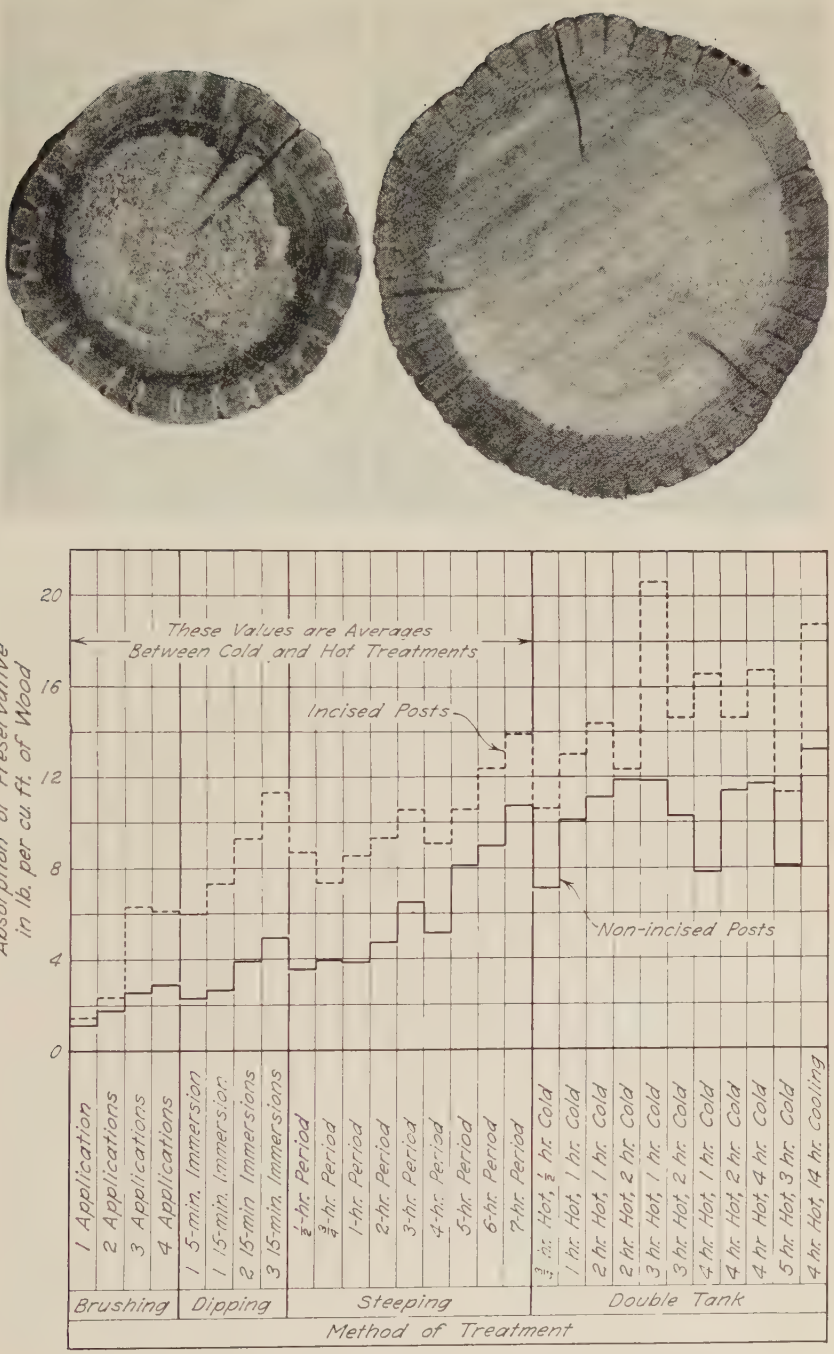

FIG. 6 (ABOVE). PENETRATION OF THE PRESERVATIVE IN INCISED WOOD
FIG. 7. ABSORPTION OF PRESERVATIVE IN POUNDS PER CUBIC FOOT OF WOOD FOR DIFFERENT PROCESSES

III. Test Lot

19. *Methods of Setting Posts.* — The specimens used in the first (May, 1922) series of tests were set during June, 1922. They were placed 2½ ft. in the ground in a small test lot, fenced off for the purpose, on the University grounds. The two halves of each post, one treated and the other untreated, were set side by side to insure that they would be subjected to the same weather and other conditions. The method of placing them is illustrated in Fig. 8.

In the second series of tests, 156 were treated in May, 1923, and the specimens were set during the next month; 30 were treated in October and set during November. The three pieces of each post were set side

Fig. 8. Arrangement of Posts Set in Test Lot in 1922
One row of each group was treated; the other was left untreated, as a control

FIG. 9. ARRANGEMENT OF POSTS SET IN TEST LOT IN 1923

One row of each group was treated, another was incised and treated, and the third was left untreated to serve as a check

FIG. 10. TEST LOT

by side, 2½ ft. in the ground, in the same test lot with those of the previous year, where they were all subjected to the same weather conditions. The method of setting them is illustrated in Fig. 9. The complete test lot is shown in Fig. 10.

20. *Termination of Tests and Removal of Posts.* — The posts had to be removed in March, 1943, to make way for the construction of one of the new buildings of the Engineering group. They were stored in a laboratory for further observational tests and measurements.

IV. Data Obtained from Later Observations

21. *Weather Conditions During the 20-Year Test Period.* — Table 8 gives data of the atmospheric temperature and moisture conditions as they existed during the 20-yr. period that the timbers were under observation. The values for temperature are averages of the daily mean in degrees Fahrenheit for the various months indicated; those for precipitation are the totals in inches for the corresponding months. The average temperature for the 22 yr. was 54 deg., and the average rainfall was 37.9 in. per yr. The figures were taken from the records of the Urbana, Illinois, Station of the Weather Bureau, U. S. Department of Commerce.

22. *Length of Life of Untreated Specimens.* — Figure 11 shows the condition of the posts at the end of about five years. Decay had eaten through the sapwood and slightly into the heartwood of 322 untreated posts at the end of 6 yr. and into the heartwood of the other 53 at the end of 8 yr. There is no way to judge how long these posts would have lasted until they would have broken under service conditions; but when they were removed in March, 1943, all had decayed off at the

Fig. 11. Decay of Untreated Posts

ground line, although a few of the tops (portions about a foot in length) were pretty well preserved. At the time of removal, most of the butts were structurally disintegrated.

23. *Length of Life of Treated Specimens.* — Of the 72 non-incised specimens treated by the brushing method, 39 were sound at the end of 6 yr., 25 at the end of 8 yr., 20 at the end of 10 yr., 15 at the end of 12 yr., 13 at the end of 14 yr., 8 at the end of 16 yr., 1 at the end of 18 yr., and none at the end of 20 yr.

Of the 24 incised pieces treated by the brushing process, all were sound at the end of 6 yr., 21 at the end of 8 yr., 19 at the end of 10 yr., 17 at the end of 12 yr., 15 at the end of 14 yr., 14 at the end of 16 yr., 13 at the end of 18 yr., and 12 at the end of 20 yr. As would be expected, those that received the best treatment lasted the longest. The data are presented in some detail in Table 9A.

Of the 54 non-incised posts that were given the dipping treatment, 31 were sound at the end of 6 yr., 22 at the end of 8 yr., 22 at the end of 10 yr., 19 at the end of 12 yr., 15 at the end of 14 yr., 12 at the end of 16 yr., 12 at the end of 18 yr., and 10 at the end of 20 yr.

Of the 24 incised specimens treated by this method, only 1 was seriously decayed at the end of 20 yr. The data are shown in further detail in Table 9B.

Of the 120 non-incised pieces treated by the steeping method, 98 were sound at the end of 6 yr., 82 at the end of 8 yr., 77 at the end of 10 yr., 70 at the end of 12 yr., 65 at the end of 14 yr., 59 at the end of 16 yr., 57 at the end of 18 yr., and 53 at the end of 20 yr.

All the incised pieces were sound at the end of 20 yr. Table 9C gives a detailed summary.

In the case of the double-tank method of treatment applied to the 106 pieces of non-incised wood, 101 were sound at the end of 6 yr., 98 at the end of 8 yr. and the same number at the end of 10 yr., 96 at the end of 12 yr., 94 at the end of 14 yr., 88 at the end of 16 yr., 87 at the end of 18 yr., and 84 or about 80 per cent at the end of 20 yr.

All of the incised specimens that were treated by the double-tank method were sound at the end of 20 yr. Table 9D presents these figures somewhat in detail.

Sloping the tops of the posts had practically no effect on the life of the wood; in all cases, failure occurred by decay at or immediately below the ground line.

The values of soundness for non-incised wood as given in the foregoing tables are summarized for comparison in Table 9E.

24. *Relationship Between Weight of Preservative per Post and Its Weight per Cubic Foot of Post.* — The relationship between the weight of the preservative per post for 42-in. lengths and its weight per cubic foot of post is shown in Fig. 12 for posts varying from 3 to 7 in. in diameter. Since this relationship is elementary and is purely mathematical, no further explanation is required.

25. *Relationship Between Weight of Preservative Injected and Volume of Impregnated Shell.* — Examinations made on 61 posts after they were taken up in March, 1943, showed the various depths of penetration of the preservative as given in Table 10. From these figures the average weight of the preservative injected per cubic inch of the impregnated shell was found to be 0.01518 lb., or about 26 lb. per cu. ft. As this is about 50 per cent above the minimum, it would seem to be sufficient for safety. This value was used to prepare Fig. 13, which gives the weights of preservative for posts 42 in. in length, varying in average diameters from 3 to 7 in. It cannot be assumed, of course, that the preservative penetrates all posts of this wood alike, for these data show that it does not; but because there is some consistency in the figures, they are presented for what they are worth. Figure 14 gives, for 42-in. posts, the relationship between the weight of

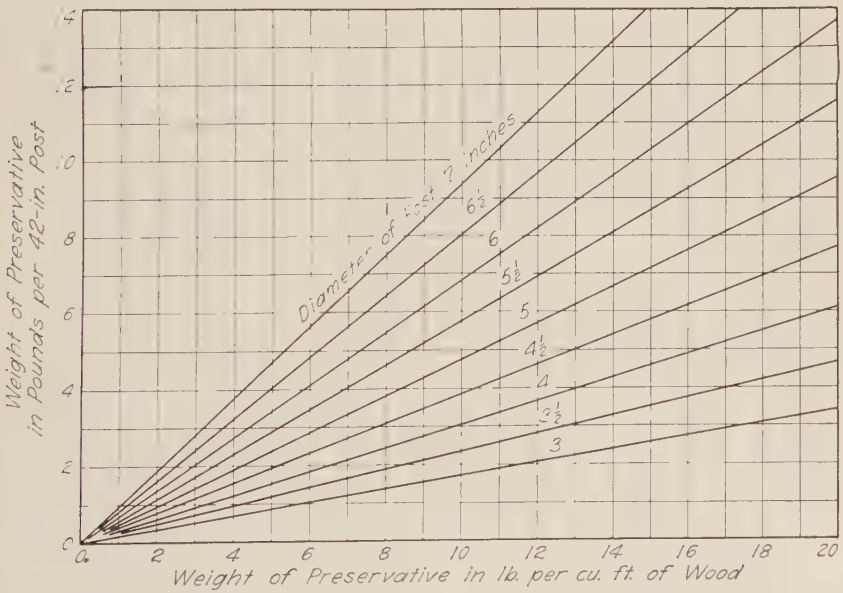

Fig. 12. Relationship Between Weight of Preservative per Post and per Cubic Foot of Wood

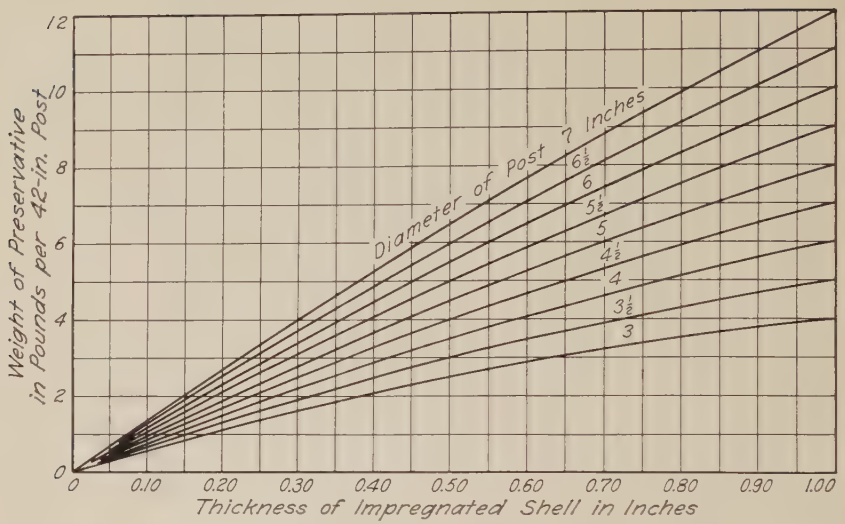

FIG. 13. RELATIONSHIP BETWEEN WEIGHT OF PRESERVATIVE INJECTED AND THICKNESS OF IMPREGNATED SHELL

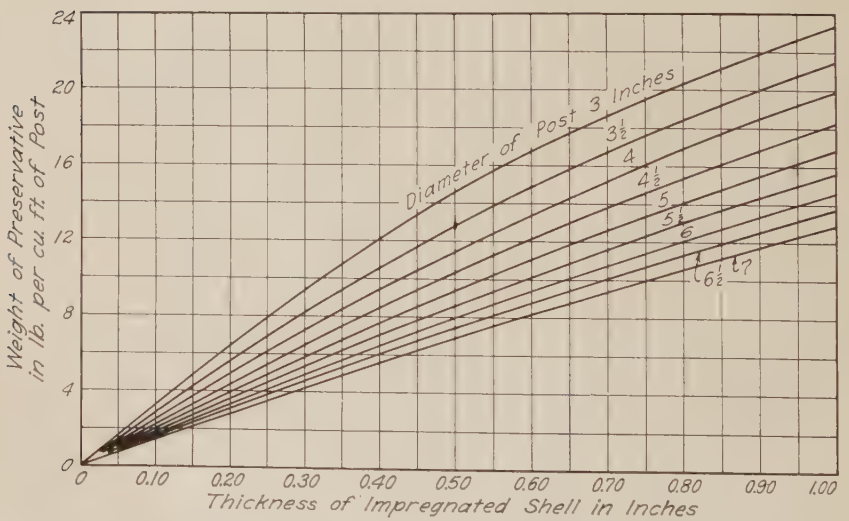

FIG. 14. RELATIONSHIP BETWEEN WEIGHT OF PRESERVATIVE IN POUNDS PER CUBIC FOOT OF POST AND THICKNESS OF IMPREGNATED SHELL — 42-IN. SPECIMENS

the preservative in pounds per cubic foot of post and the thickness of the impregnated shell.

The following example will serve to illustrate the use of the graphical data. A 6-in. post 42 in. long that contains 3.50 lb. of creosote has a protective shell of about 0.31 in. A 4-in. post of the same length that contains 3.50 lb. of creosote has a protective shell of about 0.50 in., or about two-thirds more. If, however, the figures show that the amount injected into the 6-in. post is 3.50 lb. per cu. ft. of post, which is, according to Fig. 12, about 2.40 lb. per post, the protective shell is about 0.21 in. thick. If the amount injected into the 4-in. post is 3.50 lb. per cu. ft., which is about 1.1 lb. per post, the protective shell is only 0.14 in. thick — about two-thirds as thick as that for the 6-in. post.

26. *Percentage of Creosote Retained in the Posts at the End of Twenty Years.* — An examination of 51 posts that were still sound after they were removed from the ground in March, 1943, showed weights, under practically the same moisture percentages as when originally prepared for treatment, as given in Table 11.

27. *Chemical Analyses of the Preservative Remaining in the Wood.* — Dr. J. M. Lindgren, still in charge of the Applied Chemistry Laboratory, made chemical analyses of creosote in portions of 10 posts that were typical of those specimens which were sound at the end of the test period. The samples were made up of equal portions, by weight, of the 10 posts. Sample 1 represents the outer half of that portion of the impregnated shell which was above ground; sample 2, the inner half of that portion above ground; sample 3, the outer half of that portion below ground; and sample 4, the inner half of that portion below ground. The entire samples of wood containing the preservative were ground to pieces smaller than ¼ in., and all the creosote from each sample was extracted by means of ether.

Table 12 is a résumé of the characteristics of the 10 posts chosen for chemical analysis of the contained creosote. Table 13 shows the results of the analysis of the four samples taken from each of the posts. The average pounds of creosote per cubic foot of wood actually impregnated, given in column 5 of this table, is 10.9, as compared with 13.6 in the last column of Table 12. Table 14 is a summary of these analyses. The original chemical analysis made at the time of treatment showed that 51.1 per cent of the preservative would evaporate at 315 deg. C., 48.9 per cent remaining as residue. These percentages account

for the figures in the third and fourth columns of this table, the total of 25.5 per cent being the average as given in column 9 of Table 12.

Only 4.8 lb. of preservative per cu. ft. of impregnated shell remained in the outer half of that portion of the shell that was above ground, and 6.2 lb. in the inner half of that portion, whereas 15.0 lb. remained in the outer half of that portion that was below ground and 17.4 lb. in the inner half of that portion. Altogether, on the average about 78 per cent of the preservative escaped from the upper, or exposed, portion during the 20-yr. period, and 36 per cent from the lower portion. Though a large percentage of the most highly toxic elements had disappeared from the wood by the end of the 20-yr. period, the remaining creosote still contained enough of them to preserve the wood against decay.

V. Conclusions

In evaluating the effectiveness of certain treatments and comparing various treatments, attention must be given to several factors that are influenced by the character of northern white cedar. For example, a large specimen with a relatively thin layer of sapwood will absorb less preservative, measured in pounds per cubic foot, than a small specimen with a comparatively thick sapwood.

Steeping and double-tank processes are, naturally, more effective than the more superficial methods in causing the preservative to enter the wood. The degree of penetration is affected by several factors — not merely the time of immersion and the temperature of the preservative, but the moisture content of various specimens and the thickness of their sapwood.

Practically all the incised timbers that received some kind of immersion treatment were sound at the end of the 20-yr. period. These timbers were not, of course, subjected to any of the mechanically destructive agencies that injure the surface of posts and poles in some classes of service; however, this fact only serves to emphasize that the treated surfaces should have all the protection it is possible to give them. As soon as the preservative shell surrounding the timber is broken, much of the effectiveness of the treatment is lost.

Incisions increase the absorption of the preservative oil, but as the periods of absorption became longer, increases due to incisions became smaller. Nevertheless, even for the longest periods of immersion, the additional increment of absorption and the uniformity of penetration around the surface would seem to justify commercially the expense of making the incisions where replacements of decayed poles would entail serious outlay and difficult construction.

It should be re-emphasized that the advantage of incisions is to give not only a fairly deep penetration but — and even more important — a uniform protective shell around the perimeter of the post or pole.

In order to have a protective shell ¼ in. thick according to the figures given in this publication, the rate of impregnation should be, for a 4-in. post, 42 in. long, 1.85 lb. per post, or 6.00 lb. per cu. ft. of wood per post; for a 5-in. post, 2.35 lb. per post, or 5.00 lb. per cu. ft.; and for a 6-in. post, 2.85 lb. per post, or 4.20 lb. per cu. ft. To have such a shell ½ in. thick would take something near double these amounts.

APPENDIX A. TABLES

Table 1A

Data Obtained in Brushing Treatments

Incisions	No. of Applications	Temperature of Preservative	Series No.	No. of Specimens in Test	Average Thickness of Sapwood, In.	Average Moisture Content in Per Cent of the Oven-dry Weight of Wood	Average Diameter of Posts, In.	Average Length of Posts, Ft.	Average Volume of Posts, Cu. Ft.	Average Weight of Posts, Lb.					Average Pounds of Creosote Absorbed per Post	Average Pounds of Creosote Absorbed per Cu. Ft. of Wood
										Before Treatment	After First Application	After Second Application	After Third Application	After Fourth Application		
Non-incised	1	Cold	1	9	.40	10.0	4.48	3.33	.36	8.79	9.18	.....	.....	.....	0.39	1.07
		Hot	2	9	.42	8.8	4.28	3.35	.33	8.74	9.11	.....	.....	.....	0.37	1.15
	2	Cold	3	9	.35	8.7	4.44	3.39	.36	8.74	9.04	9.30	.....	.....	0.56	1.53
		Hot	4	9	.37	9.4	4.77	3.42	.42	9.73	10.02	10.56	.....	.....	0.83	1.98
	3	Cold	5	9	.55	9.7	4.52	3.40	.38	8.81	9.29	9.47	9.58	.....	0.77	2.01
		Hot	6	9	.44	9.7	4.26	3.40	.34	8.26	8.96	9.24	9.33	.....	1.06	3.16
	4	Cold	7	9	.36	11.1	4.63	3.46	.41	9.80	10.32	10.58	10.72	10.91	1.11	2.73
		Hot	8	9	.38	10.8	4.64	3.37	.40	10.44	10.97	11.26	11.39	11.61	1.17	2.95
1½" Long., ⅛" Stagger, ½" Circum.	1	Cold	101	3	.36	9.6	5.23	3.31	.50	13.97	14.20	.....	.....	.....	0.23	0.46
		Hot	102	3	.48	7.8	4.63	3.30	.39	8.47	9.42	.....	.....	.....	0.95	2.43
	2	Cold	103	3	.40	8.5	5.64	3.27	.57	11.54	11.25	12.32	....	.....	0.78	1.38
		Hot	104	3	.52	8.2	5.37	3.26	.51	11.08	12.19	12.83	.....	.....	1.75	3.41
	3	Cold	105	3	.50	9.7	5.15	3.28	.47	10.65	12.23	12.65	13.10	.....	2.45	5.17
		Hot	106	3	.41	9.8	4.78	3.30	.41	10.17	12.33	12.83	13.23	.....	3.06	7.45
	4	Cold	107	3	.44	10.4	5.54	3.32	.55	12.24	13.67	14.58	15.00	15.49	3.25	5.85
		Hot	108	3	.40	8.8	4.76	3.26	.40	8.83	9.83	10.35	10.83	11.38	2.55	6.33

Table 1B

Data in Table 1A Summarized

Incisions	No. of Applications	Temperature of Preservative	No. of Specimens in Test	Average Thickness of Sapwood, In.	Average Moisture Content in Per Cent of the Oven-dry Weight of Wood	Average Diameter of Posts, In.	Average Length of Posts, Ft.	Average Volume of Posts, Cu. Ft.	Average Absorption in Pounds per Post	Average Absorption in Pounds per Cu. Ft. of Wood
Non-incised	1	Cold	36	.41	9.9	4.52	3.40	.38	0.42	1.07
		Hot	36	.40	9.7	4.49	3.39	.37	0.47	1.15
	2	Cold	27	.42	9.8	4.53	3.42	.38	0.66	1.74
		Hot	27	.40	10.0	4.56	3.40	.39	0.88	2.26
	3	Cold	18	.45	10.4	4.57	3.43	.39	0.85	2.18
		Hot	18	.41	10.2	4.45	3.38	.37	1.01	2.73
	4	Cold	9	.36	11.1	4.63	3.46	.41	1.11	2.73
		Hot	9	.38	10.8	4.64	3.37	.40	1.17	2.95
1½″ Long., ⅛″ Stagger, ½″ Circum.	1	Cold	12	.43	9.5	5.39	3.29	.52	0.86	1.65
		Hot	12	.45	8.6	4.89	3.28	.43	1.31	3.05
	2	Cold	9	.45	9.5	5.44	3.29	.53	1.71	3.23
		Hot	9	.45	8.9	4.97	3.27	.44	1.98	4.53
	3	Cold	6	.47	10.0	5.34	3.30	.51	2.60	5.10
		Hot	6	.41	9.3	4.77	3.28	.40	2.53	6.32
	4	Cold	3	.44	10.4	5.54	3.32	.55	3.25	5.85
		Hot	3	.40	8.8	4.76	3.26	.40	2.55	6.33

Table 2A

Data Obtained in Dipping Treatments

Incisions	No. and Period of Immersions	Temperature of Preservative	Series No.	No. of Specimens in Test	Average Thickness of Sapwood, In.	Average Moisture Content in Per Cent of the Oven-dry Weight of Wood	Average Diameter of Posts, In.	Average Leagth of Posts, Ft.	Average Volume of Posts, Cu. Ft.	Average Weight of Posts, Lb.				Average Pounds of Creosote Absorbed per Post	Average Pounds of Creosote Absorbed per Cu. Ft. of Wood
										Before Treatment	After First Treatment	After Second Treatment	After Third Treatment		
Non-incised	1—5-Min.	Cold	9	6	.39	8.3	4.32	3.44	.35	7.98	8.89	....	....	0.91	2.60
		Hot	10	6	.37	8.2	4.45	3.40	.37	8.26	8.96	....	....	0.70	1.90
	1—15-Min.	Cold	11	9	.41	10.6	4.77	3.44	.42	9.38	10.67	....	....	1.29	3.03
		Hot	12	9	.37	9.3	4.43	3.45	.37	8.00	8.82	....	....	0.82	2.21
	2—15-Min. Each	Cold	13	6	.43	9.5	4.73	3.44	.42	9.88	11.22	11.68	....	1.80	4.26
		Hot	14	6	.42	8.3	4.27	3.36	.33	7.85	8.88	9.03	....	1.18	3.52
	3—15-Min. Each	Cold	15	6	.50	7.8	4.74	3.36	.41	9.25	10.38	10.81	11.29	2.04	4.96
		Hot	16	6	.42	9.7	4.74	3.40	.42	10.09	11.74	11.83	12.13	2.04	4.90
1½″ Long., ⅛″ Stagger, ½″ Circum.	1—5-Min.	Cold	109	3	.46	7.7	4.86	3.30	.42	9.69	11.90	....	....	2.21	5.20
		Hot	110	3	.39	7.8	4.95	3.30	.44	10.07	13.02	....	....	2.95	6.75
	1—15-Min.	Cold	111	3	.41	7.0	4.70	3.30	.40	8.77	11.58	....	....	2.81	7.08
		Hot	112	3	.37	7.4	4.50	3.28	.38	8.37	11.20	....	....	2.83	7.52
	2—15-Min. Each	Cold	113	3	.48	8.7	5.28	3.23	.49	11.32	15.35	15.88	....	4.56	9.32
		Hot	114	3	.46	8.6	4.84	3.27	.42	9.56	13.29	13.40	....	3.84	9.21
	3—15-Min. Each	Cold	115	3	.57	7.8	5.61	3.30	.57	13.10	15.77	16.98	17.97	5.87	10.28
		Hot	116	3	.46	6.9	5.09	3.34	.47	11.36	16.33	16.77	17.13	5.77	12.28

TABLE 2B

DATA IN TABLE 2A SUMMARIZED

Incisions	No. of 15-Min. Immersions	Temperature of Preservative	No. of Specimens in Test	Average Thickness of Sapwood, In.	Average Moisture Content in Per Cent of the Oven-dry Weight of Wood	Average Diameter of Posts, In.	Average Length of Posts, Ft.	Average Volume of Posts, Cu. Ft.	Average Pounds of Creosote Absorbed per Post	Average Pounds of Creosote Absorbed per Cu. Ft. of Wood
Non-incised	1	Cold	21	.45	9.3	4.75	3.41	.42	1.25	3.00
		Hot	21	.40	9.1	4.48	3.40	.37	1.17	3.15
	2	Cold	12	.46	8.7	4.75	3.40	.42	1.68	4.00
		Hot	12	.42	9.0	4.50	3.38	.37	1.46	3.95
	3	Cold	6	.50	7.8	4.74	3.36	.41	2.04	4.96
		Hot	6	.42	9.7	4.77	3.40	.42	2.04	4.90
1½″ Long., ⅛″ Stagger, ½″ Circum.	1	Cold	9	.49	7.8	5.21	3.28	.49	3.50	7.21
		Hot	9	.43	7.6	4.84	3.29	.42	3.84	9.16
	2	Cold	6	.52	8.3	5.46	3.28	.53	4.72	8.91
		Hot	6	.46	7.7	4.96	3.30	.44	4.62	10.50
	3	Cold	3	.57	7.8	5.64	3.30	.57	5.87	10.28
		Hot	3	.46	6.9	5.09	3.34	.47	5.77	12.28

TABLE 3

DATA OBTAINED IN STEEPING TREATMENTS

Incisions	Period of Immersion	Temperature of Preservative	Series No	No. of Specimens in Test	Average Thickness of Sapwood, In.	Average Moisture Content in Per Cent of the Oven-dry Weight of Wood	Average Diameter of Posts, In.	Average Length of Posts, Ft.	Average Volume of Posts, Cu. Ft.	Average Weight of Posts, Lb.		Average Pounds of Creosote Absorbed per Post	Average Pounds of Creosote Absorbed per Cu. Ft. of Wood
										Before Treatment	After Treatment		
Non-incised	½ Hr.	Cold	17	6	.38	8.4	4.68	3.40	.41	9.42	10.70	1.28	3.15
		Hot	18	6	.40	9.6	4.58	3.39	.39	9.00	10.53	1.53	3.93
	¾ Hr.	Cold	19	6	.45	7.8	4.46	3.39	.37	8.55	9.94	1.39	3.78
		Hot	20	6	.40	8.9	5.27	3.30	.50	11.43	13.43	2.00	4.00
	1 Hr.	Cold	21	9	.54	10.1	4.63	3.47	.41	9.79	11.76	1.97	4.86
		Hot	22	9	.46	7.8	4.64	3.36	.40	9.59	10.68	1.09	2.74
	2 Hr.	Cold	23	9	.42	9.4	4.60	3.42	.39	9.37	11.39	2.02	5.10
		Hot	24	6	.41	8.9	5.01	3.36	.46	10.42	12.38	1.96	4.27
	3 Hr.	Cold	25	6	.41	10.6	5.00	3.38	.46	9.00	11.51	2.51	5.45
		Hot	26	6	.47	10.3	4.43	3.37	.36	8.30	10.98	2.68	7.43
	4 Hr.	Cold	27	9	.51	9.7	4.71	3.43	.42	9.46	11.75	2.29	5.48
		Hot	28	6	.41	10.9	4.90	3.45	.45	11.11	13.26	2.15	4.78
	5 Hr.	Cold	29	6	.45	7.8	4.78	3.41	.42	9.69	13.27	3.58	8.45
		Hot	30	6	.45	8.3	4.58	3.42	.39	8.74	11.76	3.02	7.64
	6 Hr.	Cold	31	6	.45	8.9	4.58	3.38	.39	7.99	11.14	3.15	8.13
		Hot	32	6	.49	8.7	4.70	3.37	.41	9.26	13.25	3.99	9.86
	7 Hr.	Cold	33	6	.47	8.9	4.29	3.41	.34	7.61	11.51	3.90	11.40
		Hot	34	6	.44	9.0	4.38	3.39	.35	8.01	11.56	3.55	10.00

TABLE 3 (CONCLUDED)

DATA OBTAINED IN STEEPING TREATMENTS

Incisions	Period of Immersion	Temperature of Preservative	Series No.	No. of Specimens in Test	Average Thickness of Sapwood, In.	Average Moisture Content in Per Cent of the Oven-dry Weight of Wood	Average Diameter of Posts, In.	Average Length of Posts, Ft.	Average Volume of Posts, Cu. Ft.	Average Weight of Posts, Lb.		Average Pounds of Creosote Absorbed per Post	Average Pounds of Creosote Absorbed per Cu. Ft. of Wood
										Before Treatment	After Treatment		
½" Long., ⅛" Stagger, ½" Circum.	½ Hr.	Cold	117	3	.44	8.8	5.00	3.37	.46	10.00	13.90	3.90	8.48
		Hot	118	3	.44	7.9	4.69	3.30	.40	9.50	12.97	3.47	8.76
	¾ Hr.	Cold	119	3	.52	8.1	5.30	3.25	.50	10.85	14.30	3.45	6.94
		Hot	120	3	.48	7.6	5.85	3.38	.63	14.49	19.40	4.91	7.80
	1 Hr.	Cold	121	3	.52	7.7	5.00	3.25	.44	9.65	13.61	3.96	9.03
		Hot	122	3	.42	8.0	4.73	3.31	.40	8.60	11.83	3.23	8.01
	2 Hr.	Cold	123	3	.40	9.1	4.86	3.24	.42	9.81	14.23	4.42	10.60
		Hot	124	3	.42	9.6	5.64	3.32	.58	12.43	17.02	4.59	7.98
	3 Hr.	Cold	125	6	.46	9.5	5.60	3.27	.56	12.16	18.55	6.39	11.45
		Hot	126	6	.44	9.9	5.35	3.28	.51	9.87	14.78	4.91	9.65
	4 Hr.	Cold	127	5	.52	9.8	5.13	3.29	.47	10.85	14.52	3.67	7.77
		Hot	128	6	.51	8.2	4.88	3.36	.44	9.82	14.27	4.45	10.25
	5 Hr.	Cold	129	6	.38	8.1	5.57	3.28	.56	11.75	17.47	5.72	10.31
		Hot	130	3	.39	8.2	5.37	3.30	.52	11.57	17.20	5.63	10.85
	6 Hr.	Cold	131	9	.50	9.3	5.36	3.29	.52	10.45	16.38	5.93	11.50
		Hot	132	3	50	7.9	5.63	3.32	.57	13.47	21.07	7.60	13.22
	7 Hr.	Cold	133	3	.50	8.1	5.02	3.31	.46	10.33	15.60	5.27	11.57
		Hot	134	3	.44	8.5	4.76	3.28	.40	9.23	15.73	6.50	16.10

TABLE 4

RELATIVE ABSORPTION OF PRESERVATIVE DURING PERIODS OF IMMERSION

Period of Immersion	Temperature of Preservative	Posts Non-incised			Posts Incised		
		No. of Specimens in Test	Average Thickness of Sapwood, In.	Average Pounds of Creosote Absorbed per Cu. Ft. of Wood	No. of Specimens in Test	Average Thickness of Sapwood, In.	Average Pounds of Creosote Absorbed per Cu. Ft. of Wood
5 Min.	Cold	6	.39	2.60	3	.46	5.20
	Hot	6	.37	1.90	3	.39	6.75
15 Min.	Cold	9	.41	3.03	3	.41	7.08
	Hot	9	.37	2.21	3	.37	7.52
30 Min.	Cold	6	.38	3.15	3	.44	8.48
	Hot	6	.40	3.93	3	.44	8.76
45 Min.	Cold	6	.45	3.78	3	.52	6.94
	Hot	6	.40	4.00	3	.48	7.80
1 Hr.	Cold	9	.54	4.86	3	.52	9.03
	Hot	9	.46	2.74	3	.42	8.01
2 Hr.	Cold	9	.42	5.10	3	.40	10.60
	Hot	6	.41	4.27	3	.42	7.98
3 Hr.	Cold	6	.41	5.45	6	.46	11.45
	Hot	6	.47	7.43	6	.44	9.65
4 Hr.	Cold	9	.51	5.48	5	.52	7.77
	Hot	6	.41	4.78	6	.51	10.25
5 Hr.	Cold	6	.45	8.45	6	.38	10.31
	Hot	6	.45	7.64	3	.39	10.85
6 Hr.	Cold	6	.45	8.13	9	.50	11.50
	Hot	6	.49	9.86	3	.50	13.22
7 Hr.	Cold	6	.47	11.40	3	.50	11.57
	Hot	6	.44	10.00	3	.44	16.10

TABLE 5

RELATIVE ABSORPTION OF NON-INCISED AND INCISED POSTS DURING SIMILAR IMMERSION PERIODS OF DIPPING AND STEEPING PROCESSES

Incisions	Dipping						Steeping					
	No. of 15-Min. Immersions	Temperature of Preservative	No. of Specimens in Test	Total Time Immersed, Min.	Average Pounds of Creosote Absorbed per Cu. Ft.	Final Average	No. of Immersions	Temperature of Preservative	No. of Specimens in Test	Total Time Immersed, Min.	Average Pounds of Creosote Absorbed per Cu. Ft.	Final Average
Non-incised	2	Cold	6	30	4.26	3.89	1	Cold	6	30	3.15	3.54
		Hot	6	30	3.52			Hot	6	30	3.93	
	3	Cold	6	45	4.96	4.93	1	Cold	6	45	3.78	3.89
		Hot	6	45	4.90			Hot	6	45	4.00	
1½″ Long., ⅛″ Stagger, ½″ Circum.	2	Cold	3	30	9.32	9.26	1	Cold	3	30	8.48	8.62
		Hot	3	30	9.21			Hot	3	30	8.76	
	3	Cold	3	45	10.28	11.28	1	Cold	3	45	6.94	7.37
		Hot	3	45	12.28			Hot	3	45	7.80	

Table 6

Data Obtained in Double-Tank Treatments

Incisions	Hours in Bath: Hot	Hours in Bath: Cold	Series No.	No. of Specimens in Test	Average Thickness of Sapwood, In.	Average Moisture Content in Per Cent of the Oven-dry Weight of Wood	Average Diameter of Posts, In.	Average Length of Posts, Ft.	Average Volume of Posts, Cu. Ft.	Average Weight of Posts, Lb.: Before Treatment	Average Weight of Posts, Lb.: After Treatment	Average Pounds of Creosote Absorbed per Post	Average Pounds of Creosote Absorbed per Cu. Ft. of Wood
Non-incised	3/4	1/2	35	9	.40	9.1	4.66	3.37	.40	9.35	12.17	2.82	7.08
	1	1	36	21	.43	8.8	4.64	3.38	.40	9.14	13.14	4.00	10.07
	2	1	37	14	.45	9.8	4.67	3.35	.40	9.19	13.60	4.41	11.13
	2	2	38	11	.45	10.6	4.67	3.34	.40	9.49	14.19	4.70	11.85
	3	1	39	9	.46	9.8	4.83	3.41	.43	10.10	15.21	5.11	11.81
	3	2	40	9	.41	8.9	4.82	3.38	.43	9.77	14.14	4.37	10.22
	4	1	41	9	.48	9.5	4.87	3.38	.43	10.20	13.55	3.35	7.80
	4	2	42	6	.40	9.6	4.52	3.40	.38	8.62	12.93	4.31	11.40
	4	4	43	6	.45	9.4	4.76	3.41	.42	9.02	13.89	4.87	11.75
	5	3	44	6	.43	11.3	4.74	3.42	.42	9.69	13.05	3.36	8.04
	4	14 cooling	45	6	.42	10.0	4.76	3.37	.42	9.92	15.42	5.50	13.20
1 1/2″ Long., 1/8″ Stagger, 1/2″ Circum.	3/4	1/2	135	3	.41	7.5	5.41	3.34	.53	11.83	17.48	5.65	10.60
	1	1	136	6		8.3	5.14	3.28	.47	10.27	16.38	6.11	12.98
	2	1	137	3	.50	9.7	5.27	3.34	.50	12.03	19.30	7.27	14.37
	2	2	138	3	.40	9.3	5.30	3.29	.50	10.91	17.12	6.21	12.31
	3	1	139	3	.52	9.6	4.85	3.31	.42	9.62	18.38	8.76	20.60
	3	2	140	6	.35	8.8	5.63	3.33	.57	12.14	20.53	8.39	14.60
	3	3	140 1/2	3	.48	10.5	4.77	3.44	.42	10.39	16.78	6.39	15.03
	4	1	141	3	.48	7.8	5.03	3.29	.45	10.16	17.64	7.48	16.55
	4	2	142	6	.50	8.6	4.83	3.33	.46	9.85	16.57	6.72	14.60
	4	4	143	3	.44	9.6	4.87	3.27	.42	8.54	15.60	7.06	16.71
	5	3	144	3	.42	11.1	5.08	3.29	.46	10.65	15.88	5.23	11.35
	4	14 cooling	145	3	.48	9.6	5.44	3.34	.54	11.43	21.52	10.09	18.79
2″ Long., 1/8″ Stagger, 1/2″ Circum.	3/4	1/2	235	3	.48	9.1	5.13	3.30	.47	11.30	15.90	4.60	9.80
	1	1	236	6	.41	9.3	5.08	3.31	.46	10.53	15.70	5.17	11.12
	2	1	237	5	.46	9.0	5.09	3.32	.47	10.80	16.48	5.68	12.15
	2	2	238	3	.42	9.8	5.31	3.28	.50	12.37	20.40	8.03	15.92
	3	1	239	3	.48	8.9	4.38	3.32	.35	8.00	13.77	5.77	16.61
	3	2	240	3	.53	9.5	5.07	3.33	.46	11.17	17.97	6.80	14.65
	4	1	241	3	.48	10.7	4.88	3.34	.43	10.10	13.30	3.20	7.36

Table 7

Relative Absorption of Non-incised and Incised Posts During Similar Immersion Periods of Steeping and Double-Tank Treatments

Incisions	Steeping					Double-Tank					
	Period of Immersion	Temperature of Preservative	No. of Specimens	Average Pounds of Creosote Absorbed per Cu. Ft.	Average, Cold and Hot	Hours in Bath: Hot	Hours in Bath: Cold	Hours in Bath: Total	No. of Specimens	Average Pounds of Creosote Absorbed per Cu. Ft.	Increase in Per Cent by Double-Tank Method
Non-incised	2 Hr.	Cold	9	5.10	4.68	1	1	2	21	10.07	115
		Hot	6	4.27							
	3 Hr.	Cold	6	5.45	6.44	2	1	3	14	11.13	73
		Hot	6	7.43							
	4 Hr.	Cold	9	5.48	5.13	2	2	4	11	11.85	131
		Hot	6	4.78		3	1	4	9	11.81	130
	5 Hr.	Cold	6	8.45	8.04	3	2	5	9	10.22	27
		Hot	6	7.64		4	1	5	9	7.80	
	6 Hr.	Cold	6	8.13	9.00	4	2	6	6	11.40	27
		Hot	6	9.86							
1½″ Long., ⅛″ Stagger, ½″ Circum.	2 Hr.	Cold	3	10.60	9.29	1	1	2	6	12.98	40
		Hot	3	7.98							
	3 Hr.	Cold	6	11.45	10.55	2	1	3	3	14.37	36
		Hot	6	9.65							
	4 Hr.	Cold	5	7.77	9.01	2	2	4	3	12.31	37
		Hot	6	10.25		3	1	4	3	20.60	128
	5 Hr.	Cold	6	10.31	10.58	3	2	5	6	14.60	38
		Hot	3	10.85		4	1	5	3	16.55	56
	6 Hr.	Cold	9	11.50	12.36	3	3	6	3	15.03	22
		Hot	3	13.22		4	2	6	6	14.60	18

Table 8

Temperature and Precipitation Statistics for Years 1922-1943 Inclusive*

Year	January		February		March		April		May		June		July		August		September		October		November		December		Av. Temp.	Total Pr.
	Temp.†	Pr.‡	Temp.	Pr.	Temp.	Pr.	Temp.	Pr.	Temp.	Pr.	Temp.	Pr.	Temp.	Pr.	Temp.	Pr.	Temp.	Pr.	Temp.	Pr.	Temp.	Pr.	Temp.	Pr.		
1922	24	1 2	32	1 6	42	8 4	53	7 6	67	3 7	75	1 5	76	2 0	75	2 8	70	0 6	57	3 2	43	2 3	31	1 8	54	36 7
1923	33	1 6	25	1 3	36	5 3	51	3 0	61	5 3	74	3 2	78	3 3	73	4 1	66	3 0	51	3 8	43	1 7	40	5 0	53	40 6
1924	21	1 7	30	1 9	36	2 7	54	3 6	57	2 7	70	8 7	74	0 9	74	8 4	61	2 2	60	1 4	42	0 8	24	6 1	50	41 1
1925	26	0 7	35	1 3	42	4 6	59	1 9	61	0 2	73	2 3	78	1 1	75	3 4	73	5 7	46	4 2	39	2 8	27	1 2	53	29.4
1926	28	1 9	34	3 0	34	2 8	45	4 0	66	2 3	69	3 6	78	4 4	76	4.0	66	9 8	54	4 5	37	2 5	28	0 9	51	46 6
1927	26	1 7	38	1 2	44	3 8	52	6 5	61	5 0	69	5 9	75	6 0	68	4 8	71	7 1	59	3 6	45	6 8	29	3 6	53	56 0
1928	28	2 2	32	2 3	40	1 5	48	3 2	64	2 5	67	4 7	77	3 7	76	2 8	63	3 7	58	2 3	42	1 9	34	2 5	54	33.3
1929	22	3 6	24	0 5	47	2 9	55	6 4	60	7 8	71	2 9	77	6 3	72	4 8	66	0 9	54	3 8	37	1 3	30	3 0	51	44.2
1930	22	4 8	40	1 8	38	1 9	56	4 1	66	1 5	75	2 2	81	0 5	77	2 0	69	3 0	53	1 6	42	1 5	31	0 2	54	26 9
1931	33	0 5	37	1 3	36	2 6	54	4 4	63	4 0	76	6 9	81	1 7	75	2 9	73	5 4	59	2 3	50	2 5	40	2 0	57	36 5
1932	35	2 6	39	1 7	33	1 8	54	1 3	65	1 3	76	3 6	80	2 4	76	2 6	67	3 6	54	3 8	36	2 4	29	3 3	54	31 4
1933	36	2 0	29	1 4	40	5 4	53	3 4	65	5 8	81	1 2	81	0 6	75	4 4	73	5 1	53	3 4	41	0 7	34	1 1	55	34 5
1934	33	1 4	25	0 8	35	3 6	53	1 0	71	0 5	81	5 3	84	2 1	75	4 9	64	7 0	56	0 9	46	5 4	29	2 2	54	35 1
1935	29	2 2	33	1 3	46	2 7	50	2 9	58	6 9	69	3 6	79	4 1	75	2 4	67	3.9	56	1 7	40	4 3	25	1 3	56	37 3
1936	20	1 3	20	2 8	43	1 6	50	3 0	67	3 9	73	0 5	81	1 4	81	3 5	71	5 8	55	3.5	38	4 2	34	3 7	53	35 2
1937	28	6 0	29	1 5	38	0 8	50	5 4	65	2 6	72	5 4	78	2 4	78	0 8	67	5 3	52	3 9	38	1 5	28	2 1	52	37 7
1938	28	1 6	38	2 3	48	7 2	55	3 4	64	5 0	73	5 7	78	6 5	77	4 3	69	0 9	60	2 5	44	1 6	32	2 0	55	43 0
1939	34	3 7	30	3 7	43	4 8	49	5 4	69	1 2	75	6 2	78	1 7	75	6 4	73	0 3	57	2 5	42	1 1	34	0 9	55	37 9
1940	16	1 4	31	1 1	38	2 1	51	4 0	60	4 5	75	5 0	79	1 0	78	2 8	67	0 5	60	1 9	39	3 8	35	2 5	52	30 6
1941	30	1 3	28	0 6	36	1 5	60	4 2	69	3 9	76	6 2	81	3 3	74	3 6	70	4 9	59	9 0	44	3 3	37	1 0	55	42 8
1942	28	1 9	28	3 8	43	4 1	62	3 3	64	3 6	73	3 9	80	4 9	71	2 6	66	3 9	56	2 4	44	5 4	26	2.5	54	42 3
1943	28	0 6	33	1 1	38	3 8	51	3 5	63	11 2	76	2 4	81	1 4	78	3 9	64	2 1	56	2 0	39	2 2	29	1 3	53	35 5
Av.	27	2 1	31	1 7	40	3 6	53	3 9	64	3 9	74	4 1	79	2 8	75	3.7	68	3 8	56	3 1	44	2 7	31	2 4	54	37 9

* From records of U. S. Department of Commerce, Weather Bureau, Urbana (Illinois) Station.
† Degrees Fahrenheit.
‡ Inches.

Table 9A

Endurance Ability of Brush-Treated Posts

Incisions	No. of Applications	Temperature of Preservative	Series No.	No. of Specimens in Test	Condition of Posts at the End of								
					6 Yr.	8 Yr.	10 Yr.	12 Yr.	14 Yr.	16 Yr.	18 Yr.	20 Yr.	
					Sound	Sound	Sound	Sound	Sound	Sound	Sound	Sound	Serviceable
Non-incised	1	Cold	1	9	3	2	1	1	...	...	...	...	1
		Hot	2	9	2	...	...	...	...	...	...	...	2
	2	Cold	3	9	5	1	1	...	...	...	...	...	5
		Hot	4	9	5	3	2	1	1	...	...	...	7
	3	Cold	5	9	4	4	3	3	3	3	1	...	2
		Hot	6	9	5	3	3	3	3	1	...	...	5
	4	Cold	7	9	6	6	5	4	4	4	...	...	7
		Hot	8	9	9	6	5	3	2	...	...	...	6
1½″ Long., ⅛″ Stagger, ½″ Circum.	1	Cold	101	3	3	3	1	1	...	...	...	...	1
		Hot	102	3	3	1	1	...	...	...	...	...	1
	2	Cold	103	3	3	2	2	2	2	2	1	1	2
		Hot	104	3	3	3	3	2	2	1	1	1	3
	3	Cold	105	3	3	3	3	3	2	2	2	1	2
		Hot	106	3	3	3	3	3	3	3	3	3	3
	4	Cold	107	3	3	3	3	3	3	3	3	3	3
		Hot	108	3	3	3	3	3	3	3	3	3	3

Table 9B
Endurance Ability of Dip-Treated Posts

Incisions	No. and Period of Immersions	Temperature of Preservative	Series No.	No. of Specimens in Test	Condition of Posts at the End of								
					6 Yr.	8 Yr.	10 Yr.	12 Yr.	14 Yr.	16 Yr.	18 Yr.	20 Yr.	
					Sound	Sound	Sound	Sound	Sound	Sound	Sound	Sound	Serviceable
Non-incised	1—5-Min.	Cold	9	6	3	1	1	...	...	...	...	...	2
		Hot	10	6	3	1	1	1	...	...	...	...	2
	1—15-Min.	Cold	11	9	6	3	3	2	2	1	1	...	7
		Hot	12	9	3	3	3	3	2	1	1	1	1
	2—15-Min. Each	Cold	13	6	4	4	4	3	2	2	2	2	5
		Hot	14	6	4	3	3	3	3	2	2	1	3
	3—15-Min. Each	Cold	15	6	4	4	4	4	3	3	3	3	6
		Hot	16	6	4	3	3	3	3	3	3	3	4
1½″ Long., ⅛″ Stagger, ½″ Circum.	1—5-Min.	Cold	109	3	3	3	3	3	3	3	3	3	3
		Hot	110	3	3	3	3	3	3	3	2	2	2
	1—15-Min.	Cold	111	3	3	3	3	3	3	3	3	3	3
		Hot	112	3	3	3	3	3	3	3	3	3	3
	2—15-Min. Each	Cold	113	3	3	3	3	3	3	3	3	3	3
		Hot	114	3	3	3	3	3	3	3	3	3	3
	3—15-Min. Each	Cold	115	3	3	3	3	3	3	3	3	3	3
		Hot	116	3	3	3	3	3	3	3	3	3	3

Table 9C

Endurance Ability of Steep-Treated Posts

Incisions	Period of Immersion	Temperature of Preservative	Series No.	No. of Specimens in Test	Condition of Posts at the End of								
					6 Yr.	8 Yr.	10 Yr.	12 Yr.	14 Yr.	16 Yr.	18 Yr.	20 Yr.	
					Sound	Sound	Sound	Sound	Sound	Sound	Sound	Sound	Serviceable
Non-incised	½ Hr.	Cold	17	6	3	3	3	3	3	2	2	1	2
		Hot	18	6	4	2	1	1	1	...	...	...	4
	¾ Hr.	Cold	19	6	5	4	4	2	2	2	2	2	4
		Hot	20	6	5	4	4	4	3	3	3	2	4
	1 Hr.	Cold	21	9	5	4	4	3	3	3	3	3	7
		Hot	22	9	7	3	3	2	2	1	1	1	3
	2 Hr.	Cold	23	9	8	8	6	6	6	6	6	6	7
		Hot	24	6	4	4	4	4	4	3	3	3	5
	3 Hr.	Cold	25	6	5	4	4	3	3	3	3	3	3
		Hot	26	6	4	4	4	4	3	3	3	3	5
	4 Hr.	Cold	27	9	8	7	7	5	4	4	4	3	8
		Hot	28	6	6	5	5	5	3	3	3	3	5
	5 Hr.	Cold	29	6	5	5	5	5	5	5	5	5	6
		Hot	30	6	6	4	4	4	4	4	4	3	5
	6 Hr.	Cold	31	6	5	4	4	4	4	4	4	4	5
		Hot	32	6	6	5	4	4	4	4	4	4	6
	7 Hr.	Cold	33	6	6	6	6	6	6	4	4	4	6
		Hot	34	6	6	6	5	5	5	5	3	3	6

TABLE 9C (CONCLUDED)
ENDURANCE ABILITY OF STEEP-TREATED POSTS

Incisions	Period of Immersion	Temperature of Preservative	Series No.	No. of Specimens in Test	Condition of Posts at the End of								
					6 Yr.	8 Yr.	10 Yr.	12 Yr.	14 Yr.	16 Yr.	18 Yr.	20 Yr.	
					Sound	Sound	Sound	Sound	Sound	Sound	Sound	Sound	Serviceable
$1\frac{1}{2}$″ Long., $\frac{1}{8}$″ Stagger, $\frac{1}{2}$″ Circum.	½ Hr.	Cold	117	3	3	3	3	3	3	3	3	3	3
		Hot	118	3	3	3	3	3	3	3	3	3	3
	¾ Hr.	Cold	119	3	3	3	3	3	3	3	3	3	3
		Hot	120	3	3	3	3	3	3	3	3	3	3
	1 Hr.	Cold	121	3	3	3	3	3	3	3	3	3	3
		Hot	122	3	3	3	3	3	3	3	3	3	3
	2 Hr.	Cold	123	3	3	3	3	3	3	3	3	3	3
		Hot	124	3	3	3	3	3	3	3	3	3	3
	3 Hr.	Cold	125	6	6	6	6	6	6	6	6	6	6
		Hot	126	6	6	6	6	6	6	6	6	6	6
	4 Hr.	Cold	127	5	5	5	5	5	5	5	4	4	5
		Hot	128	6	6	6	6	6	6	6	6	6	6
	5 Hr.	Cold	129	6	6	6	6	6	6	6	6	6	6
		Hot	130	3	3	3	3	3	3	3	3	3	3
	6 Hr.	Cold	131	9	9	9	9	9	9	9	9	9	9
		Hot	132	3	3	3	3	3	3	3	3	3	3
	7 Hr.	Cold	133	3	3	3	3	3	3	3	3	3	3
		Hot	134	3	3	3	3	3	3	3	3	3	3

Table 9D
Endurance Ability of Double-Tank Treated Posts

Incisions	Hours in Bath		Series No.	No. of Specimens in Test	Condition of Posts at the End of								
					6 Yr.	8 Yr.	10 Yr.	12 Yr.	14 Yr.	16 Yr.	18 Yr.	20 Yr.	
	Hot	Cold			Sound	Sound	Sound	Sound	Sound	Sound	Sound	Sound	Serviceable
Non-incised	¾	½	35	9	7	7	7	7	7	7	7	6	9
	1	1	36	21	19	18	18	17	16	16	16	15	21
	2	1	37	14	13	13	13	13	13	11	11	11	13
	2	2	38	11	11	10	10	10	10	10	9	9	10
	3	1	39	9	9	9	9	9	8	8	8	8	9
	3	2	40	9	9	9	9	9	9	8	8	8	9
	4	1	41	9	9	9	9	8	8	8	8	8	8
	4	2	42	6	6	6	6	6	6	5	5	5	6
	4	4	43	6	6	6	6	6	6	4	4	4	6
	5	3	44	6	6	6	6	6	6	6	6	5	6
	4	14 cooling	45	6	6	5	5	5	5	5	5	5	6
1½″ Long., ⅛″ Stagger, ½″ Circum.	¾	½	135	3	3	3	3	3	3	3	3	3	3
	1	1	136	9	9	9	9	9	9	9	9	9	9
	2	1	137	6	6	6	6	6	6	6	6	6	6
	2	2	138	6	6	6	6	6	6	6	6	6	6
	3	1	139	3	3	3	3	3	3	3	3	3	3
	3	2	140	6	6	6	6	6	6	6	6	6	6
	3	3	140½	3	3	3	3	3	3	3	3	3	3
	4	1	141	3	3	3	3	3	3	3	3	3	3
	4	2	142	6	6	6	6	6	6	6	6	6	6
	4	4	143	3	3	3	3	3	3	3	3	3	3
	5	3	144	3	3	3	3	3	3	3	3	3	3
	4	14 cooling	145	3	3	3	3	3	3	3	3	3	3
2″ Long., ⅛″ Stagger, ½″ Circum.	¾	½	235	3	3	3	3	3	3	3	3	3	3
	1	1	236	6	6	6	6	6	6	6	6	6	6
	2	1	237	5	5	5	5	5	5	5	5	5	5
	2	2	238	3	3	3	3	3	3	3	3	3	3
	3	1	239	3	3	3	3	3	3	3	3	3	3
	3	2	240	3	3	3	3	3	3	3	3	3	3
	4	1	241	3	3	3	3	3	3	3	3	3	3

TABLE 9E

CONDITION OF NON-INCISED POSTS AT THE END OF TWENTY YEARS: SUMMARY

Treatment		Temperature of Preservative	Series No.	No. of Specimens in Test	Average Pounds of Creosote Absorbed per Cu. Ft. of Wood	Number of Posts Sound at the End of								Number Serviceable at the End of 20 Years
						6 Yr.	8 Yr.	10 Yr.	12 Yr.	14 Yr.	16 Yr.	18 Yr.	20 Yr.	
Brushing	1 Application	Cold	1	9	1.07	3	2	1	1	...	...	...	...	1
		Hot	2	9	1.15	2	...	...	...	...	...	...	...	2
	2 Applications	Cold	3	9	1.53	5	1	1	...	...	...	...	...	5
		Hot	4	9	1.98	5	3	2	1	1	...	...	...	7
	3 Applications	Cold	5	9	2.01	4	4	3	3	3	3	1	...	2
		Hot	6	9	3.16	5	3	3	3	3	1	...	...	5
	4 Applications	Cold	7	9	2.73	6	6	5	4	4	4	...	...	7
		Hot	8	9	2.95	9	6	5	3	2	...	...	...	6
Dipping	1—5-Min. Immersion	Cold	9	6	2.60	3	1	1	...	...	...	...	...	2
		Hot	10	6	1.90	3	1	1	1	...	...	...	...	2
	1—15-Min. Immersion	Cold	11	9	3.03	6	3	3	2	2	1	1	...	7
		Hot	12	9	2.21	3	3	3	3	2	1	1	1	1
	2—15-Min. Immersions	Cold	13	6	4.26	4	4	4	3	2	2	2	2	5
		Hot	14	6	3.52	4	3	3	3	3	2	2	1	3
	3—15-Min. Immersions	Cold	15	6	4.96	4	4	4	4	3	3	3	3	6
		Hot	16	6	4.90	4	3	3	3	3	3	3	3	4

TABLE 9E (CONCLUDED)

CONDITION OF NON-INCISED POSTS AT THE END OF TWENTY YEARS: SUMMARY

Treatment		Temperature of Preservative	Series No.	No. of Specimens in Test	Average Pounds of Creosote Absorbed per Cu. Ft. of Wood	Number of Posts Sound at the End of								Number Serviceable at the End of 20 Years
						6 Yr.	8 Yr.	10 Yr.	12 Yr.	14 Yr.	16 Yr.	18 Yr.	20 Yr.	
Steeping	½-Hr. Immersion	Cold	17	6	3.15	3	3	3	3	3	2	2	1	2
		Hot	18	6	3.93	4	2	1	1	1	...	...	...	4
	¾-Hr. Immersion	Cold	19	6	3.78	5	4	4	2	2	2	2	2	4
		Hot	20	6	4.00	5	4	4	4	3	3	3	2	4
	1-Hr. Immersion	Cold	21	9	4.86	5	4	4	3	3	3	3	3	7
		Hot	22	9	2.74	7	3	3	2	2	1	1	1	3
	2-Hr. Immersion	Cold	23	9	5.10	8	8	6	6	6	6	6	6	7
		Hot	24	6	4.27	4	4	4	4	4	3	3	3	5
	3-Hr. Immersion	Cold	25	6	5.45	5	4	4	3	3	3	3	3	3
		Hot	26	6	7.43	4	4	4	4	3	3	3	3	5
	4-Hr. Immersion	Cold	27	9	5.48	8	7	7	5	4	4	4	3	8
		Hot	28	6	4.78	6	5	5	5	3	3	3	3	5
	5-Hr. Immersion	Cold	29	6	8.45	5	5	5	5	5	5	5	5	6
		Hot	30	6	7.64	6	4	4	4	4	4	4	3	5
	6-Hr. Immersion	Cold	31	6	8.13	5	4	4	4	4	4	4	4	5
		Hot	32	6	9.86	6	5	4	4	4	4	4	4	6
	7-Hr. Immersion	Cold	33	6	11.40	6	6	6	6	6	4	4	4	6
		Hot	34	6	10.00	6	6	5	5	5	5	3	3	6
Double-Tank	¾ Hr. Hot, ½ Hr. Cold		35	9	7.08	7	7	7	7	7	7	7	6	9
	1 Hr. Hot, 1 Hr. Cold		36	21	10.07	19	18	18	17	16	16	16	15	21
	2 Hr. Hot, 1 Hr. Cold		37	14	11.13	13	13	13	13	13	11	11	11	13
	2 Hr. Hot, 2 Hr. Cold		38	11	11.85	11	10	10	10	10	10	9	9	10
	3 Hr. Hot, 1 Hr. Cold		39	9	11.81	9	9	9	9	8	8	8	8	9
	3 Hr. Hot, 2 Hr. Cold		40	9	10.22	9	9	9	9	9	8	8	8	9
	4 Hr. Hot, 1 Hr. Cold		41	9	7.80	9	9	9	8	8	8	8	8	8
	4 Hr. Hot, 2 Hr. Cold		42	6	11.40	6	6	6	6	6	5	5	5	6
	4 Hr. Hot, 4 Hr. Cold		43	6	11.75	6	6	6	6	6	4	4	4	6
	5 Hr. Hot, 3 Hr. Cold		44	6	8.04	6	6	6	6	6	6	6	5	6
	4 Hr. Hot, 14 Hr. Cooling		45	6	13.20	6	5	5	5	5	5	5	5	6

Table 10

Relation Between Weight of Preservative Injected and Volume of Impregnated Shell

Incisions	Treatment		Post No.	Thickness of Sapwood, In.	Average Diameter of Posts, In.	Length of Posts, In.	Min. Thickness of Impregnated Shell, In.	Max. Thickness of Impregnated Shell, In.	Av. Thickness of Impregnated Shell, In.	Volume of Impregnated Shell, Cu. In.	Weight of Preservative Injected, Lb.	Weight of Preservative in Lb. per Cu. In. of Shell
Non-incised	Dipping	3—15-Min. App. Hot	245-1	.62	4.53	40.87	.40	.75	.62	312	3.94	.01264
	Steeping	½ Hr. Hot	65	.30	5.22	41.25	.20	.42	.30	191	2.07	.01850
		¾ Hr. Cold	69	.44	4.03	41.87	.25	.50	.35	169	1.57	.00930
		1 Hr. Cold	273-1	.38	4.00	39.75	.35	.65	.40	179	2.24	.01248
		1 Hr. Hot	278-1	.38	4.03	39.75	.23	.55	.40	181	1.68	.00927
		2 Hr. Cold	316-1	.50	4.25	39.62	.18	.60	.40	192	2.30	.01201
		2 Hr. Cold	157	.44	4.56	39.38	.20	.55	.40	206	2.49	.01212
		2 Hr. Cold	158	.56	4.47	41.50	.50	.80	.55	281	3.60	.01283
		3 Hr. Cold	323-1	.44	4.22	39.50	.40	.70	.50	231	3.90	.01688
		3 Hr. Hot	324-1	.38	4.25	40.50	.22	.50	.39	191	3.10	.01625
		4 Hr. Cold	144	.62	5.19	41.00	.30	.75	.50	302	4.22	.01398
		5 Hr. Cold	172	.50	4.72	42.75	.44	.68	.50	284	4.35	.01532
		5 Hr. Cold	174	..	4.56	42.00	.30	.80	.50	268	3.31	.01835
		5 Hr. Hot	178	.56	4.69	41.12	.12	.62	.50	271	3.33	.01230
		5 Hr. Hot	179	.56	4.31	42.50	.20	.65	.35	185	2.75	.01485
		7 Hr. Cold	190	.44	4.53	43.50	.25	.65	.50	276	4.35	.01575
	Double-Tank	¾ Hr. Hot, ½ Hr. Cold	105	.50	5.31	40.12	.15	.65	.40	247	3.18	.01290
		1 Hr. Hot, 1 Hr. Cold	107	.50	4.93	41.62	.18	.50	.40	237	3.67	.01550
		1 Hr. Hot, 1 Hr. Cold	282-1	..	3.97	40.12	.20	.80	.50	218	3.04	.01395
		1 Hr. Hot, 1 Hr. Cold	286-1	..	4.03	39.00	.59	.60	.55	234	4.05	.01730
		2 Hr. Hot, 1 Hr. Cold	375-1	.50	5.25	38.50	.20	.55	.40	235	3.20	.01361
		2 Hr. Hot, 1 Hr. Cold	109	.44	4.94	43.00	.33	.60	.44	267	4.68	.01752
		2 Hr. Hot, 2 Hr. Cold	119	.50	4.72	40.75	.25	.80	.45	246	3.12	.01258
		3 Hr. Hot, 1 Hr. Cold	295-1	.56	4.72	40.75	.65	1.00	.75	381	7.28	.01910
		3 Hr. Hot, 1 Hr. Cold	112	.38	4.78	42.50	.25	.50	.35	207	2.89	.01395
		3 Hr. Hot, 1 Hr. Cold	114	.38	5.06	40.75	.25	.63	.52	302	4.49	.01490
		3 Hr. Hot, 2 Hr. Cold	383-1	.70	5.75	40.00	.22	.70	.50	340	5.30	.01555
		3 Hr. Hot, 2 Hr. Cold	299-1	.38	5.69	40.00	.30	.70	.55	355	5.84	.01645
		3 Hr. Hot, 2 Hr. Cold	127	.38	4.50	41.25	.08	.50	.38	202	2.39	.01184
		3 Hr. Hot, 2 Hr. Cold	129	.38	4.72	43.75	.40	.80	.50	291	4.82	.01654
		4 Hr. Hot, 1 Hr. Cold	122	.44	4.56	41.50	.44	.90	.60	310	4.46	.01440
		4 Hr. Hot, 1 Hr. Cold	123	.50	4.78	40.75	.20	.60	.40	224	2.76	.01231
		4 Hr. Hot, 1 Hr. Cold	302-1	.50	4.09	39.62	.65	.80	.65	278	5.44	.01958

TABLE 10 (CONCLUDED)

RELATION BETWEEN WEIGHT OF PRESERVATIVE INJECTED AND VOLUME OF IMPREGNATED SHELL

Incisions	Treatment		Post No.	Thickness of Sapwood, In.	Average Diameter of Posts, In.	Length of Posts, In.	Min. Thickness of Impregnated Shell, In.	Max. Thickness of Impregnated Shell, In.	Av. Thickness of Impregnated Shell, In.	Volume of Impregnated Shell, Cu. In.	Weight of Preservative Injected, Lb.	Weight of Preservative in Lb. per Cu. In. of Shell
Non-incised	Double-Tank	4 Hr. Hot, 2 Hr. Cold	130	.38	4.78	42.50	.30	.60	.42	245	4.53	.01850
		4 Hr. Hot, 2 Hr. Cold	132	.38	5.22	41.50	.22	.58	.40	251	4.97	.01982
		4 Hr. Hot, 4 Hr. Cold	135	.70	5.56	41.00	.31	.70	.45	296	5.46	.01845
		4 Hr. Hot, 14 Hr. Cooling	124	.38	4.69	40.50	.35	.69	.50	267	4.66	.01759
		4 Hr. Hot, 14 Hr. Cooling	126	.38	4.78	40.50	.20	.55	.42	233	2.82	.01211
		5 Hr. Hot, 3 Hr. Cold	137	.25	5.03	41.00	.28	.50	.45	265	4.79	.01270
		5 Hr. Hot, 3 Hr Cold	138	.44	4.53	42.12	.25	.62	.44	243	2.80	.01153
		5 Hr. Hot, 3 Hr. Cold	314-1	.44	4.40	39.75	.25	.65	.45	222	4.10	.01845
	Brushing	4 Applications Hot	221-2	.50	4.90	39.00	.40	.85	.62	325	3.10	.00955
	Dipping	3—15-Min. App. Hot	245-2	.62	5.16	39.75	.62	.90	.80	439	6.88	.01565
1½" Long, ⅛" Stagger, ½" Circum.	Steeping	½ Hr. Cold	263-2	.56	4.53	42.00	.60	.80	.70	353	4.30	.01218
		¾ Hr. Cold	269-2	.50	5.16	39.50	.41	.72	.60	339	4.90	.01445
		¾ Hr. Hot	270-2	.44	5.97	41.25	.55	.85	.62	424	5.52	.01302
		1 Hr. Cold	273-2	.38	4.84	39.38	.40	.80	.60	345	3.80	.01205
		2 Hr. Cold	316-2	.50	4.75	40.00	.60	.78	.65	335	5.29	.01551
		3 Hr. Cold	323-2	.44	4.85	38.50	.50	.65	.70	362	6.26	.01731
		3 Hr. Cold	213-2	.44	4.97	39.00	.65	.85	.70	367	6.36	.01731
		3 Hr. Hot	213-1	.44	4.93	40.50	.60	.90	.70	376	4.66	.01241
		3 Hr. Hot	324-2	.38	4.87	38.50	.40	.59	.45	241	4.60	.01907
		4 Hr. Hot	206-1	.62	4.69	41.75	.42	.80	.75	386	6.08	.01575
	Double-Tank	1 Hr. Hot, 1 Hr. Cold	282-2	. .	4.81	39.25	.62	.90	.75	375	4.76	.01270
		1 Hr. Hot, 1 Hr. Cold	286-2	. .	4.53	39.25	.50	.80	.60	291	4.76	.01638
		2 Hr. Hot, 1 Hr. Cold	375-2	.50	5.81	39.87	.48	.78	.62	403	5.90	.01462
		2 Hr. Hot, 2 Hr. Cold	376-2	.50	4.81	39.87	.70	.90	.78	394	8.10	.02057
		3 Hr. Hot, 1 Hr. Cold	295-2	.56	4.97	40.00	.67	1.10	1.00	509	9.88	.01976
		3 Hr. Hot, 2 Hr. Cold	299-2	.38	6.15	39.25	.60	.90	.80	528	10.00	.01894
		4 Hr. Hot, 1 Hr. Cold	302-2	.50	4.59	40.00	.65	1.00	.80	380	6.98	.01840
		4 Hr. Hot, 14 Hr. Cooling	309-2	.62	6.34	39.75	.70	1.20	1.00	668	12.86	.01925
												0.01490
Average Non-incised (41)												0.01574
Average Incised (20)												0.01518
Final Average (61)												

TABLE 11

AMOUNT OF PRESERVATIVE RETAINED AT THE END OF TWENTY YEARS

Incisions	Treatment		Post No.	Average Diameter of Post, In.	Weight of Post, Lb.			Pounds of Creosote Absorbed by Post	Amount of Creosote Retained After 20 Yr.	
					Before Treatment	After Treatment	After 20 Yr.		Lb.	Per Cent
Non-incised	Dipping	3—15-Min. App. Hot	245-1	4.53	8.70	12.64	11.01	3.94	2.31	59
	Steeping	¾ Hr. Cold	69	4.03	7.34	8.91	7.56	1.57	.22	14
		1 Hr. Hot	278-1	4.03	6.30	7.98	7.07	1.68	.77	46
		2 Hr. Cold	157	4.56	7.47	9.96	8.11	2.49	.64	26
		2 Hr. Cold	158	4.47	7.82	11.42	9.51	3.60	1.69	47
		3 Hr. Cold	323-1	4.22	7.40	11.30	10.30	3.90	2.90	74
		3 Hr. Hot	324-1	4.25	6.40	9.50	8.56	3.10	2.16	70
		5 Hr. Cold	174	4.56	8.99	12.30	10.76	3.31	1.77	53
		7 Hr. Cold	190	4.53	7.40	11.75	9.02	4.35	1.62	37
	Double-Tank	1 Hr. Hot, 1 Hr. Cold	107	4.93	10.73	14.40	12.21	3.67	1.48	41
		1 Hr. Hot, 1 Hr. Cold	282-1	3.97	7.20	10.24	9.05	3.04	1.85	61
		1 Hr. Hot, 1 Hr. Cold	286-1	4.03	5.95	10.00	8.54	4.05	2.59	64
		2 Hr. Hot, 1 Hr. Cold	375-1	5.25	11.00	14.20	12.47	3.20	1.47	46
		2 Hr. Hot, 1 Hr. Cold	109	4.94	9.90	14.58	12.05	4.68	2.15	46
		2 Hr. Hot, 2 Hr. Cold	119	4.72	11.13	14.25	12.42	3.12	1.29	41
		3 Hr. Hot, 1 Hr. Cold	295-1	4.72	8.60	15.88	13.83	7.28	5.23	72
		3 Hr. Hot, 1 Hr. Cold	112	4.78	10.80	13.69	11.92	2.89	1.12	39
		3 Hr. Hot, 1 Hr. Cold	114	5.06	10.81	15.30	13.14	4.49	2.33	52
		3 Hr. Hot, 2 Hr. Cold	383-1	5.75	13.50	18.80	16.20	5.30	2.70	51
		3 Hr. Hot, 2 Hr. Cold	299-1	5.69	12.70	18.54	16.68	5.84	3.98	68
		4 Hr. Hot, 1 Hr. Cold	122	4.56	11.60	16.06	14.00	4.46	2.40	54
		4 Hr. Hot, 1 Hr. Cold	123	4.78	10.24	13.00	11.45	2.76	1.21	44
		4 Hr. Hot, 1 Hr. Cold	302-1	4.09	6.86	12.30	10.47	5.44	3.61	66
		4 Hr. Hot, 2 Hr. Cold	130	4.78	9.21	13.74	11.95	4.53	2.74	60
		4 Hr. Hot, 2 Hr. Cold	132	5.22	13.00	17.97	15.39	4.97	2.39	48
		4 Hr. Hot, 4 Hr. Cold	135	5.56	12.02	17.48	15.24	5.46	3.22	59
		4 Hr. Hot, 14 Hr. Cooling	124	4.69	9.20	13.86	11.90	4.66	2.70	58
		4 Hr. Hot, 14 Hr. Cooling	126	4.78	10.75	13.57	12.02	2.82	1.27	45
		5 Hr. Hot, 3 Hr. Cold	137	5.03	10.56	15.35	13.40	4.79	2.84	59
		5 Hr. Hot, 3 Hr. Cold	138	4.53	8.82	11.62	10.07	2.80	1.25	45
		5 Hr. Hot, 3 Hr. Cold	314-1	4.40	8.40	12.50	11.34	4.10	2.94	72

TABLE 11 (CONCLUDED)

AMOUNT OF PRESERVATIVE RETAINED AT THE END OF TWENTY YEARS

Incisions	Treatment		Post No.	Average Diameter of Post, In.	Weight of Post, Lb.			Pounds of Creosote Absorbed by Post	Amount of Creosote Retained After 20 Yr.	
					Before Treatment	After Treatment	After 20 Yr.		Lb.	Per Cent
1½″ Long., ⅛″ Stagger, ½″ Circum.	Brushing	4 Applications Hot	221-2	4.90	9.10	12.20	9.86	3.10	0.76	25
	Dipping	3—15-Min. Ea. Hot	245-2	5.16	11.12	18.00	14.97	6.88	3.85	56
	Steeping	¾ Hr. Cold	268-2	5.12	10.24	12.90	11.23	2.66	0.99	37
		¾ Hr. Cold	269-2	5.16	11.40	16.30	13.82	4.90	2.42	49
		¾ Hr. Hot	270-2	5.97	14.48	20.00	17.97	5.52	3.49	63
		1 Hr. Cold	273-2	4.84	10.24	14.04	12.46	3.80	2.22	58
		2 Hr. Cold	316-2	4.75	8.60	13.80	11.47	5.20	2.87	55
		3 Hr. Cold	323-2	4.85	9.24	15.50	12.58	6.26	3.34	53
		3 Hr. Hot	213-2	4.97	10.34	16.70	13.14	6.36	2.80	44
		3 Hr. Cold	213-1	4.93	8.44	13.10	11.25	4.66	2.81	60
		3 Hr. Hot	324-2	4.87	8.00	12.60	11.32	4.60	3.32	72
		4 Hr. Hot	206-1	4.69	9.12	15.20	12.07	6.08	2.95	49
	Double-Tank	1 Hr. Hot, 1 Hr. Cold	282-2	4.81	9.94	14.70	13.04	4.76	3.10	65
		1 Hr. Hot, 1 Hr. Cold	286-2	4.53	7.72	12.48	10.84	4.76	3.12	66
		2 Hr. Hot, 1 Hr. Cold	375-2	5.81	14.10	20.00	18.20	5.90	4.10	70
		2 Hr. Hot, 2 Hr. Cold	376-2	4.81	9.30	17.40	14.70	8.10	5.40	67
		3 Hr. Hot, 1 Hr. Cold	295-2	4.97	9.72	19.60	14.72	9.88	5.00	51
		3 Hr. Hot, 2 Hr. Cold	299-2	6.15	13.90	23.90	21.09	10.00	7.19	72
		4 Hr. Hot, 1 Hr. Cold	302-2	4.59	8.40	15.38	12.73	6.98	4.33	62
		4 Hr. Hot, 14 Hr. Cooling	309-2	6.34	15.10	27.96	21.94	12.86	6.84	53

TABLE 12

SUMMARY OF THE CHARACTERISTICS OF THE TEN POSTS FROM WHICH CREOSOTE SAMPLES WERE EXTRACTED FOR CHEMICAL ANALYSIS

Post No.	Vol. of Post, Cu. In	Wt. of Post in Pounds Before Treatment	Wt. of Untreated Wood in Pounds per Cu. Ft.	Av. Thickness of Impregnated Shell	Vol. of Impregnated Shell, Cu. In.	Weight in Pounds of Preservative in Post at Time of Treatment			Weight in Pounds of Preservative in Post After Twenty Years of Exposure		
						Total Post	Per Cu. In. of Impregnated Shell	Per. Cu. Ft. of Impregnated Shell	Total Post	Per Cu. In. of Impregnated Shell	Per Cu. Ft. of Impregnated Shell
69	538.1	7.34	23.4	0.35	169	1.57	0.00930	16.1	0.22	0.00130	2.2
114	821.1	10.81	22.8	0.52	302	4.49	.01490	25.8	2.33	.00773	13.3
123	736.4	10.24	24.1	0.40	224	2.76	.01231	21.3	1.21	.00540	9.3
179	623.1	8.18	22.7	0.35	185	2.75	.01485	25.7	....	.....	....
278-1	506.8	6.30	21.5	0.40	181	1.68	.00927	16.0	0.77	.00425	7.4
286-1	498.0	5.95	20.6	0.55	234	4.05	.01730	29.9	2.59	.01107	19.1
286-2	635.1	7.72	21.0	0.60	291	4.76	.01638	28.3	3.12	.01072	18.5
299-1	1019.0	12.70	21.7	0.55	355	5.84	.01615	28.4	3.98	.01121	19.4
309-2	1258.1	15.10	20.8	1.00	668	12.86	.01925	33.3	6.84	.01024	17.7
323-2	718.8	9.24	22.3	0.70	362	6.26	.01731	30.2	3.34	.00922	15.8
Average	.....	....	22.1	....	...	....	0.01473	25.5	....	0.00790(9)	13.6(9)

TABLE 13

CHEMICAL ANALYSES OF PRESERVATIVE REMAINING IN THE WOOD OF THE TEN POSTS AT THE END OF THE TWENTY-YEAR TEST PERIOD

Sample No.	Wt. of Sample in Grams (Wood + Creosote)	Per Cent Extracted of Total Weight	Wt. in Grams of Creosote Extracted per 100 Grams of Wood	Pounds of Creosote Extracted per Cu. Ft. of Wood Actually Impregnated*	Relative Per Cent of Creosote Extracted						Residue
					Up to 210° C	210-235° C	235-300° C	300-315° C	315-335° C	Total at 335° C	Per Cent
1	402.5	17.9	21.8	4.8	1.40	3.10	9.5	5.1	13.8	32.9	67.2
2	353.0	21.8	27.9	6.2	0.05	0.05	11.3	8.5	28.9	48.8	50.7
3	423.0	40.5	68.0	15.0	0.03	1.30	9.0	9.5	40.0	59.8	40.0
4	351.0	44.0	78.7	17.4	0.01	1.20	12.0	17.4	34.0	64.6	34.5
Average	.....	...	...	10.9	....	...	....	....	....	....	....

* Based on 22.1 pounds per cubic foot of wood as per Table 12.

TABLE 14

SUMMARY OF CHEMICAL ANALYSES

Sample No.	Original Creosote			Samples After Twenty Years of Exposure						Av. Amount per Cu. Ft. of Wood in Impregnated Shell That Disappeared During the Twenty-Year Period			
	Total Pounds per Cu. Ft. of Wood in Impregnated Shell	Pounds per Cu. Ft. of Wood in Impregnated Shell Distillable at 315° C	Pounds per Cu. Ft. of Wood Residue at 315° C	Pounds That Remained per Cu. Ft. of Wood		Per Cent of Total Original	Pounds per Cu. Ft. of Wood That Distilled at 315° C		Pounds per Cu. Ft. of Wood That Was Residue at 315° C		Pounds	Per Cent of Total Original	Pounds Distillable at 315° C	Pounds Residue at 315° C
				Total	Av.		Total	Av.	Total	Av.				
1	25.5	13.0	12.5	4.8	5.5	22	0.9	1.1	3.9	4.4	20.0	78	11.9	8.1
2				6.2			1.3		4.9					
3	25.5	13.0	12.5	15.0	16.2	64	3.0	4.1	12.0	12.1	9.3	36	8.9	0.4
4				17.4			5.3		12.1					

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